September 19, 2011

Attention: Derek Starnes
Yellowhead County
2716 1st Avenue
Edson AB T7E 1N9

Re: **Acoustical Measurements and Recommendations**
Evansburg Pembina Arena
Our file: 2010-2918 Rev 1

Derek:

As requested, Patching Associates conducted measurements at the Evansburg Pembina Arena on November 19, 2010. The background sound level and reverberation time of the arena has been calculated and acoustical treatment recommendations assembled where required.

Reverberation Time

Reverberation time is the time it takes a sound or noise emitted in a room to decay 60dB (essentially to become inaudible). It can be difficult to hear intelligibly in a room with a long reverberation time because the sound of a voice is bounced around the space and decays (becomes quieter) slowly, making it hard to identify what a speaker is saying amongst the 'reverberating' (reflecting) sound from their previous words. Where sound is continually introduced into the space, the reverberant noise level will build up, and can mask the ongoing words/music.

The reverberation time of a space is dependent on the volume, surface area and types of surfaces within the space. Problems with reverberation are often caused by too much or too little sound reflecting off surfaces around the room instead of diffusing or being absorbed into them. For example, when more acoustically absorbent materials are integrated into a room its reverberation time is lowered.

The existing acoustic absorption of the Evansburg Pembina Arena was determined from reverberation measurements taken by PAAE staff on November 19, 2010. The Reverberation time measurements were taken by the interrupted noise method, using a Brüel & Kjær Model 2250 precision integrating sound level meter, equipped with a Brüel & Kjær 4188 microphone (mounted with a windscreen), BZ-7228 building acoustics software outputting through two 800 Watt amplified loudspeakers. The calibration of the sound level meter was checked at the beginning and end of the measurements with a Brüel & Kjær Model 4231 calibrator. The reverberation measurements were taken in two different speaker placement configurations, at three positions for each configuration, with three decays at each position. The results of the measurements were averaged to obtain the reverberation time of the overall space.

The acoustic target for the arena is to achieve a reverberation time that is optimal for popular music performance (e.g. a country or rock band that brings in their own amplification equipment and plays to a crowd of people within the rink space) and for general usage. The dimensions of the space were used to calculate the optimal reverberation time using a chart of preferred reverberation times based on type of use[1]. The amount of additional acoustic absorption to achieve the optimal reverberation time was calculated from the measured and optimal reverberation times.

Table 1 – Evansburg Pembina Arena Reverberation Measurement Results

Test Description		1/3rd Octave Band Centre Frequency (Hz)																	
Speaker Config.	Mic. Pos#	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Facing S& E in SE Corner	1	0.5	0.7	1.9	1.8	3.2	4.6	1.6	4.5	6.0	4.4	4.8	4.6	3.6	3.0	2.1	1.7	1.2	0.9
	2	0.6	0.6	2.9	3.4	3.4	4.8	2.6	4.7	6.0	5.2	5.0	4.7	3.8	2.8	1.8	1.5	1.1	0.9
	3	0.7	0.5	3.3	2.8	3.5	3.8	2.3	4.6	5.5	4.9	4.4	4.3	4.3	2.7	2.0	1.5	1.2	1.0
Both Facing SE Corner	1	0.6	0.5	3.1	3.5	2.9	4.4	2.0	3.1	5.8	4.9	4.8	5.0	3.5	2.6	1.9	1.4	1.2	1.0
	2	0.7	0.7	1.7	2.9	4.0	4.0	3.0	3.7	5.4	5.6	5.4	4.9	3.6	2.9	2.0	1.5	1.2	1.0
	3	0.6	0.7	2.5	2.9	3.8	4.2	2.3	4.3	5.4	5.7	5.3	4.5	3.6	3.1	1.9	1.5	1.2	1.0
SW & SE Corners	1	0.7	1.7	2.7	3.5	4.3	4.9	4.7	5.2	6.7	6.3	5.9	5.3	4.5	3.3	2.6	1.9	1.6	1.2
	2	0.5	0.6	2.5	4.2	5.6	4.3	3.5	5.2	6.4	6.5	6.1	5.4	4.2	3.1	2.6	2.0	1.6	1.2
	3	0.6	1.9	3.6	4.3	4.6	4.3	4.3	5.5	6.9	6.4	6.3	5.4	4.7	4.0	2.9	2.1	1.7	1.2
	4	0.4	1.1	3.1	3.2	4.7	5.0	3.9	5.3	6.8	6.4	6.3	5.5	4.6	3.8	2.8	2.0	1.6	1.3
Room Average 1/3rd Octaves		0.7	1.0	2.7	3.2	4.0	4.4	3.0	4.6	6.1	5.6	5.4	5.0	4.0	3.1	2.3	1.7	1.3	1.1
Room Average Octave Bands			**1.5**			**3.9**			**4.6**			**5.3**			**3.1**			**1.4**	

*Measurements in red were not used for averaging as they did not meet quality requirements

Figure 1 (on the following page) illustrates the measured reverberation time compared to the recommended time for several different occupancy scenarios.

When sound waves collide with a surface or object, their energy is partially reflected and partially absorbed. The percentage of sound energy absorbed by a surface or object is quantified with an absorption coefficient. There are several different ways to express a material's acoustic absorption. In this report, absorption has been described using metric Sabines which are expressed in square metres (m^2); one metric Sabine is the absorption of one square metre of a perfect absorber (a material that absorbs 100% of incoming sound energy). Another common metric for acoustic absorption is the Noise Reduction Coefficient (NRC). The NRC is the average of the frequency specific absorption coefficients over the range of human speech (250, 500, 1000 and 2000 Hz). Most acoustic material suppliers provide an NRC in their product specifications. To calculate the total absorption (in metric Sabines) of a material using its NRC, multiply the NRC by the surface area (in square metres) of the material.

[1] K. Ginn. "Architectural Acoustics, Application of B&K Equipment". Figure 2.12. NAERUM Publishing, Denmark. 1978.

Figure 1 - Recommended Reverberation Time by Room Volume and Use

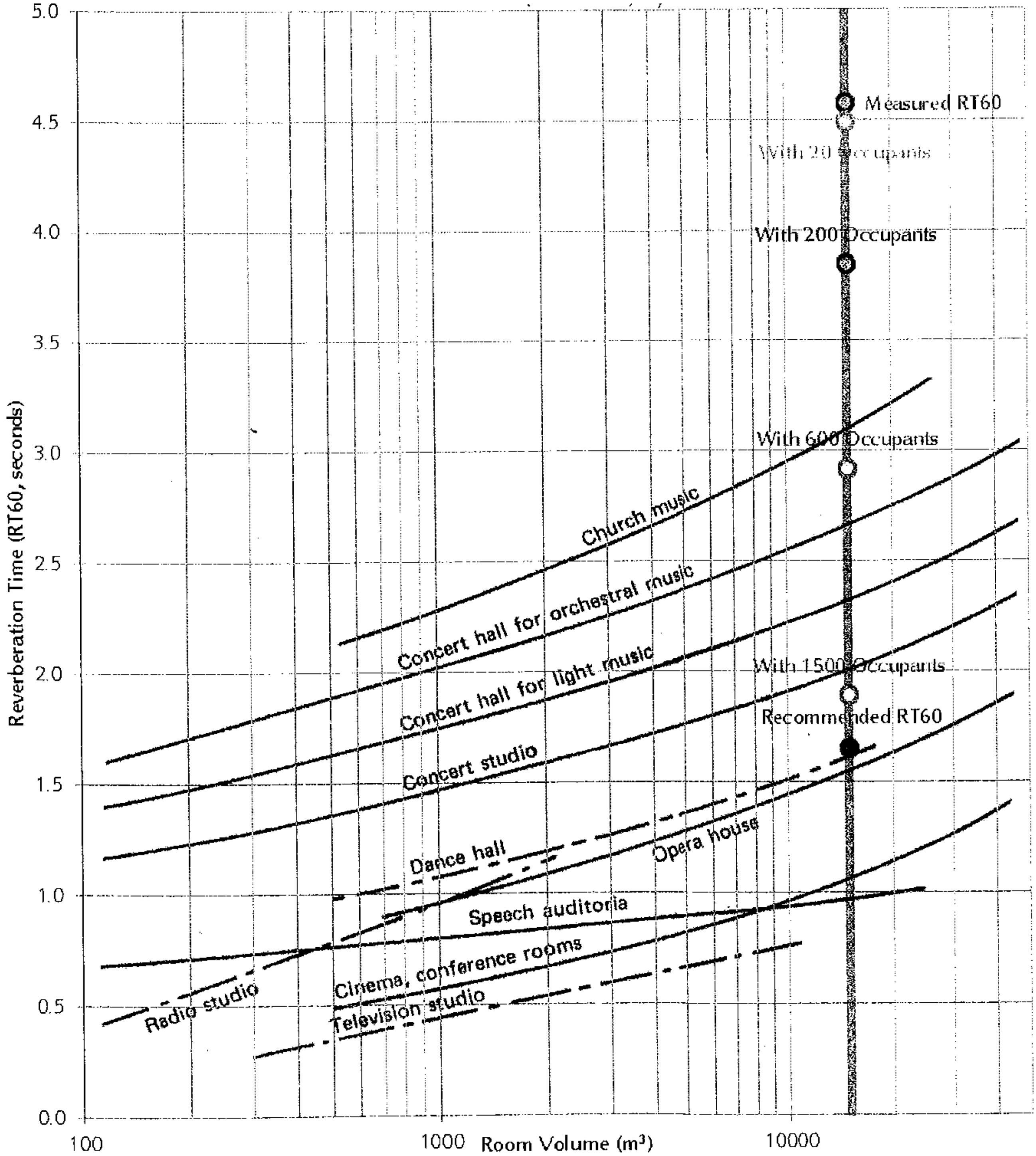


Figure Source: K. Ginn. "Architectural Acoustics, Application of B&K Equipment". Figure 2.12. NAERUM Publishing, Denmark. 1978.

Table 2 - Acoustic Treatment Recommendation

Description	Octave Band Centre Frequency (Hz)					
	125	250	500	1000	2000	4000
Measured Reverberation Time, Unoccupied (RT60, sec)	1.5	3.9	4.6	5.3	3.1	1.4
Recommended RT60 (sec)	2.3	2.0	1.7	1.6	1.5	1.5
Existing Acoustic Absorption (Metric Sabines, m^2)	1631	622	528	453	771	1750
Absorption Required to Meet Recommended RT60 (MS, m^2)	1045	1220	1428	1557	1565	1574
Additional Absorption Recommended with 20 Occupants (MS, m^2)	**0**	**593**	**890**	**1094**	**782**	**0**
Additional Absorption Recommended with 200 Occupants (MS, m^2)	**0**	**551**	**800**	**998**	**674**	**0**
Additional Absorption Recommended with 600 Occupants (MS, m^2)	**0**	**458**	**600**	**784**	**434**	**0**
Additional Absorption Recommended with 1500 Occupants (MS, m^2)	**0**	**248**	**150**	**304**	**0**	**0**

The level of additional acoustic absorption recommended varies with the level of occupancy (people have a small amount of acoustic absorption, which can become significant in large numbers). Additional acoustic absorption can be achieved by adding materials/treatments that are acoustically absorptive to the room; there are a wide variety of products/treatments available. Please see Appendix B for a listing of acoustic product suppliers in your region. PAAE is a completely independent consulting firm and has no affiliations with suppliers of acoustic products or materials. We are not recommending the listed suppliers over any other vendors; we encourage you to consult search engines and telephone directories for additional suppliers.

Common types of acoustical treatment that may be recommended by suppliers for your project include: baffles, wall panels and banners.

Figure 2 - Illustration of Common Forms of Acoustic Treatment Materials

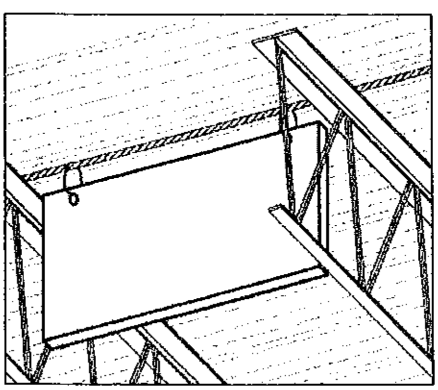


Figure 2.1 – Sketch of an Acoustic Baffle

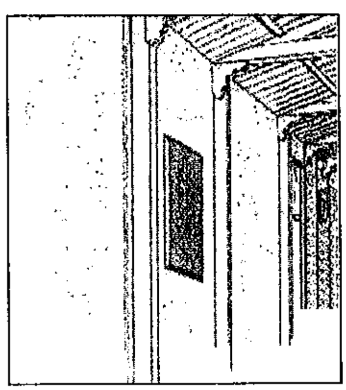


Figure 2.2 – Sketch of an Acoustic Wall Panel

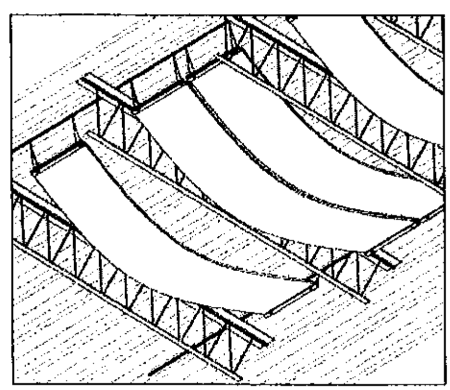


Figure 2.3 – Sketch of Acoustic Banners

Many acoustical products can be customized to meet more than just the acoustical needs of the space. For instance, the acoustic panels used for wall treatment can also be used as pin boards or be printed with photographs, advertisements or artwork, and acoustic baffles often double as signs or banners.

For the purpose of this report, we have approximated the performance of acoustical baffles, panels and banners in order to estimate how much treatment is recommended. We have assumed an NRC rating of 0.75 for a 1″ panel, 1.0 for a 2″ panel, 0.85 for acoustic banners, and 0.95 for a 2″ acoustic baffle. Individual products will vary, but this simplification allows for an estimation of how much treatment is required without selecting a specific product.

Table 3 - Approximation of Treatment Area Recommended

Occupancy Scenario	Approximate Treatment Area Recommended (m^2)			
	1" Panels (NRC 0.75)	Acoustic Banners (NRC 0.85)	2" Baffles (NRC 0.9)	2" Panels (NRC 1)
With 200 Occupants	1067	941	889	800
With 600 Occupants	800	706	667	600
With 1500 Occupants	200	176	167	150

Background Sound Level

The background sound level is the sound level of an un-occupied room under normal operating conditions. The background sound level of a room can strongly affect a person's ability to understand verbal signals in the room. When background sound levels are very low, problems with speech privacy and disruption often occur because typical vocal levels are much higher than the background levels, allowing them to carry further before becoming masked (blending in with the noise environment). When background sound levels are too high, difficulties are encountered with verbal communication, requiring speakers to raise their voice and/or more amplification to be used. As such, it is best to design for a background sound level that falls within a recommended minimum and maximum for the use of the space. For this assessment we have used the Room Criterion (RC) Curves to compare the existing background sound levels with the recommended range. The RC curves are a widely recognized rating system used by mechanical engineers in the design of HVAC systems and are recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The recommended range for similar performance spaces (qualified as large seating-capacities with speech amplification) is RC 45-55[2].

Background sound level measurements were recorded in one-third octave band with a Brüel & Kjær Model 2250 precision integrating sound level meter which was equipped with a Brüel & Kjær 4188 microphone (mounted with a windscreen).

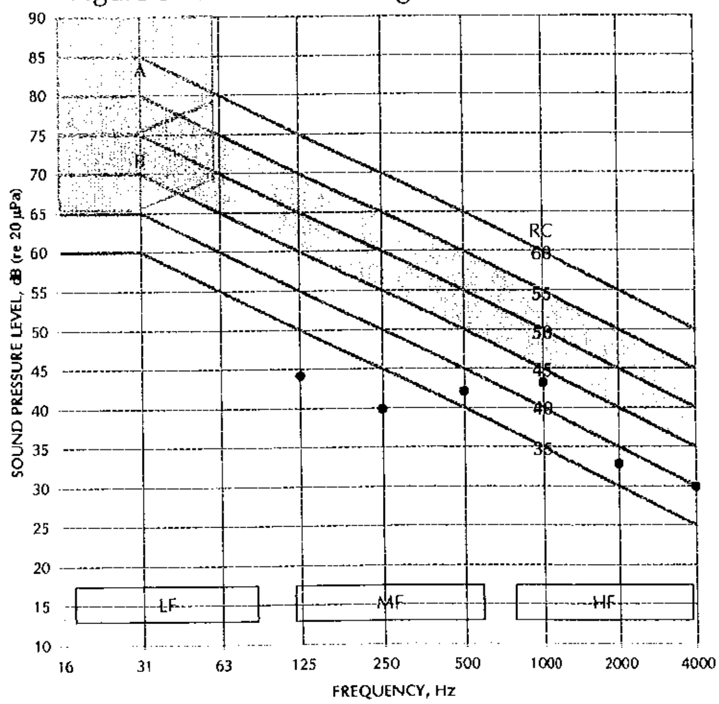
The measured background sound level is RC 39 (HF), this falls below the recommended range for the desired use of the space; however, we are not recommending any corrective treatment for the background level at this time as the background level is not sufficiently low to definitively say that it will be problematic. Since the acoustically sensitive use of the space would be under concert conditions, when it is fully occupied and there is amplified sound, a background level below recommended levels may not be a significant issue. We recommend treating for the reverberation time first, and re-assessing the background level afterwards if further acoustical improvement is desired.

[2] ASHRAE 2007 Handbook Chapter 47, Table 42 – Design Guidelines for HVAC-Related Background Sound in Rooms

Table 3 – Background Sound Level Measurement and Calculation

Descriptor	Octave Band Centre Frequency, Hz								
	16	**31**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
Spectrum Levels				44	40	42	43	33	30
Average of 500 to 2000 Hz Levels								**39**	
RC Contour	64	64	59	54	49	44	39	34	29
Levels - RC Contour				-10	-9	-2	4	-1	1
Spectral Deviations	LF			MF			HF		
				-5.4			1.9		
RC Mark II Rating	**RC 39 (HF)**								

Figure 3 - Measured Background Sound Level



I trust that this is the information you require at this time. If you have any questions, please contact me at (403) 274-5882.

Sincerely,
Patching Associates Acoustical Engineering Ltd.

Jessie Roy, E.I.T.

Encl.
Appendix A – Acoustical Treatment Requirement Summary
Appendix B – Architectural Acoustic Product Suppliers in the Edmonton Area
Appendix C – Technical Details Regarding Sound Measurement and Analysis

APPENDIX A

Acoustical Treatment Requirement Summary

Acoustical Treatment Requirement Summary

Location: **Evansburg Pembina Arena**
Room: ***Main Arena***
Desired Room Use: *Multi-purpose Hall (Amplified Music Performance with Crowd & Everyday Rink Use)*
Room Volume: *15000 m^3*

Descriptor	Octave Band Centre Frequency (Hz)					
	125	250	500	1000	2000	4000
Reverberation Time, Unoccupied (RT60, sec)	1.5	3.9	4.6	5.3	3.1	1.4
Recommended RT60 (sec)	2.3	2.0	1.7	1.6	1.5	1.5

Descriptor	Octave Band Centre Frequency (Hz)					
	125	250	500	1000	2000	4000
Existing Acoustic Absorption (Metric Sabines, m^2)	1631	622	528	453	771	1750
Absorption Required to Meet Recommended RT60 (m^2)	1045	1220	1428	1557	1565	1574
Existing Acoustic Absorption with 20 Occupants (m2)	1633	627	538	463	783	1762
Existing Acoustic Absorption with 200 Occupants (m2)	1657	669	628	559	891	1870
Existing Acoustic Absorption with 600 Occupants (m2)	1711	762	828	773	1131	2110
Existing Acoustic Absorption with 1500 Occupants (m2)	1831	972	1278	1253	1671	2650
Additional Absorption Recommended with 20 Occupants (m2)	0	593	890	1094	782	0
Additional Absorption Recommended with 200 Occupants (m2)	0	551	800	998	674	0
Additional Absorption Recommended with 600 Occupants (m2)	0	458	600	784	434	0
Additional Absorption Recommended with 1500 Occupants (m2)	0	248	150	304	0	0

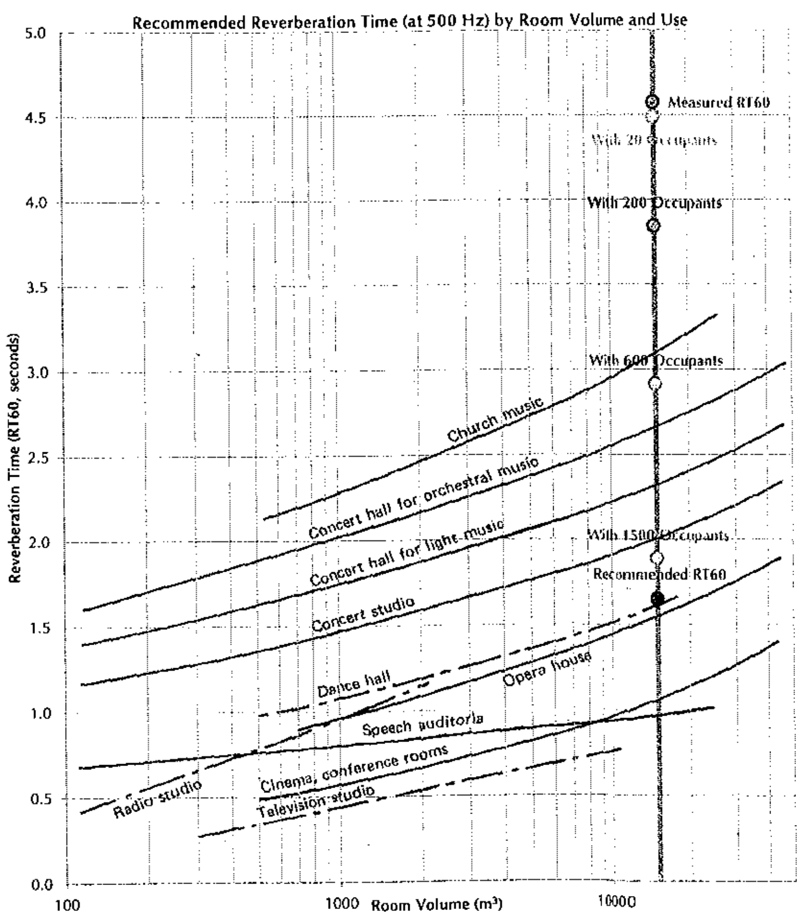


Figure Source: K. Ginn, "Architectural Acoustics, Application of B&K Equipment", Figure 2.12. NAERUM Publishing, Denmark. 1978.

Additional Requirements for Acoustical Product:
Check All That Apply

- ○ Water Resistant
- ○ Fire Resistant
- ○ Mold Resistant
- ○ Washable
- ○ Impact Resistant
- ○ Other: ______

APPENDIX B

Architectural Acoustic Product Suppliers
Edmonton Area

Architectual Acoustic Product Suppliers

Edmonton Area

Supplier	Website	Phone
Acoustex Group	http://www.acoustex.net	1-877-226-8789
Acoustic Solutions Ltd.	http://www.acousticsolutions.com	780-423-2109
Acoustics West Manufacturing Ltd.	http://www.acousti-trac.com	250-380-4048
Eckel Noise Control Technologies	http://www.eckel.ca	613-543-2967
Fabra-Wall Acoustic Systems	http://www.fabra-wall.com	403-547-8350
GWP Wallworks	http://www.wallworks.com	403-255-3550
Sound-Rite Acoustics Inc.	http://www.sound-rite.com	780-414-1756
The Wenger Corporation	http://www.wengercorp.com	1-800-268-7477
Western Noise Control	http://www.acousticsolutions.com	780-423-2119

PAAE is a completely independent consulting firm and has no affiliations with suppliers of acoustic products or materials. We are not recommending the suppliers listed above over any other vendors; we encourage you to consult search engines and telephone directories for additional suppliers.

APPENDIX C

Explanation of Technical Details Regarding Sound Measurement and Analysis

Technical Details

Sound is the phenomena of vibrations transmitted through air, or other medium such as water or a building structure. The range of pressure amplitudes, intensities, and frequencies of the sound energy is very wide, and many specialized fields have developed using different ranges of these variables, such as room acoustics and medical ultrasound.

Due to the wide range of intensities, which are perceived as sound, standard engineering units become inconvenient. Sound levels are commonly measured on a logarithmic scale, with the level (in decibels, or dB) being proportional to ten times the common logarithm of the sound energy or intensity. Normal human hearing covers a range of about twelve to fourteen orders of magnitude in energy, from the threshold of hearing to the threshold of pain. On the decibel scale, the threshold of hearing is set as zero, written as 0 dB, while the threshold of pain varies between 120 to 140 dB. The most usual measure of sound is the sound pressure level (SPL), with 0 dB SPL set at 2.0 X 10^{-5} N/m^2 (also written 20 μPa), which corresponds to a sound intensity of 10^{-12} Watts/m^2 (or 1 picoWatt/m^2, written 1 pW/m^2).

Normal human hearing spans a frequency range from about 20 Hertz (Hz, or cycles per second) to about 20,000 Hz (written 20 KHz). However, the sensitivity of human hearing is not the same at all frequencies. To accommodate the variation in sensitivity, various frequency-weighting scales have been developed. The most common is the A-weighting scale, which is based on the sensitivity of human hearing at moderate levels; this scale reflects the low sensitivity to sounds of very high or very low frequencies. Sound levels measured on the A-weighted scale are written in A-weighted decibels, commonly shown as dBA or dB(A).

When sound is measured using the A-weighting scale, the reading is often called the "Noise level", to confirm that human sensitivity and reactions are being addressed. A table of some common noise sources and their associated noise levels are shown in Table C1.

When the A-weighting scale is not used, the measurement is said to have a "linear" weighting, or to be unweighted, and may be called a "linear" level. As the linear reading is an accurate measurement of the physical (sound) pressure, the term "Sound Pressure Level", or SPL, is usually (but not universally) reserved for unweighted measurements.

Noise is usually defined as "unwanted sound", which indicates that it is not just the physical sound that is important, but also the human reaction to the sound that leads to the perception of sound as noise. It implies a judgment of the quality or quantity of sound experienced. As a human reaction to sound is involved, noise levels are usually given in A-weighted decibels (dBA). An alternate definition of noise is "sound made by somebody else", which emphasizes that the ability to control the level of the sound alters the perception of noise.

Table C1- Noise Levels of Familiar Sources

Source Or Environment	Noise Level (dBA)
High Pressure Steam Venting To Atmosphere (3m)	121
Steam Boiler (2m)	90-95
Drilling Rig (10m)	80-90
Pneumatic Drill (15m)	85
Pump Jack (10m)	68-72
Truck (15m)	65-70
Business Office	65
Conversational Speech (1m)	60
Light Auto Traffic (30m)	50
Living Room	40
Library	35
Soft Whisper (5m)	20-35

The single number A-weighted level is often inadequate for engineering purposes, although it does supply a good estimate of people's reaction to a noise environment. As noise sources, control measures, and materials differ in the frequency dependence of their noise responses or production, sound is measured with a narrower frequency bandwidth; the specific methodology varies with the application. For most work, the acoustic frequency range is divided into frequency bands where the center frequency of each band is twice the frequency of the next lower band; these are called "Octave" bands, as their frequency relation is called an "Octave" in music, where the field of acoustics has its roots. For more detailed work, the octave bands, and certain standard octave and 1/3 octave bands have been specified by international agreements.

Where the noise at the receiver is steady, it is easy to assess the noise level. However, both the production of noise at the source and the transmission of noise can vary with time; most noise levels are not constant, either because of the motion of the noise source (as in traffic noise), because the noise source itself varies, or because the transmission of sound to the receiver location is not steady as over long distances. This is almost always the case for environmental noise studies. Several single number descriptors have been developed and are used to assess noise in these conditions.

The most common is the measurement of the "equivalent continuous" sound level, or L_{eq}, which is the level of a hypothetical source of a constant level which would give the same total sound energy as is measured during the sampling period. This is the "energy" average noise level. Typical sampling periods are one hour, nighttime (9 hours) or one day (24 hours); the sampling period used must be reported when using this unit.

The greatest value of the L_{eq} is that the contributions of different sources to the total noise level can be assessed, or in a case where a new noise source is to be added to an existing environment, the total noise level from new and old sources can be easily calculated. It is also sensitive to short term high noise levels.