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National Acoustic Laboratories
A division of Australian Hearing

Acoustic tests on the Goodear Acoustic Shield

Introduction

At the request of Symphony Services International the National Acoustic Laboratories (NAL), Australia, carried out a series of acoustic attenuation tests on an acoustic shield that is specifically designed to reduce the overall sound exposure of orchestral musicians who regularly perform in large ensembles. Musicians working in large ensembles are exposed to high levels of sound and consequently are susceptible to damage to their hearing health (noise injury) in a similar manner to those who work in industrial noise. With this in mind it is prudent for those responsible for these workplaces to examine appropriate and effective methods of reducing sound exposure levels.

Operation

The shield, the Goodear, is normally located closely behind the head position of the affected musician to block (attenuate) a portion of the sound coming from instruments located to the rear. In a typical orchestral setting, for example, this would be most effective for woodwind players who are located directly in front of the brass section. During particularly loud sections of brass playing the Goodear is positioned to reduce the volume of the music experienced by the woodwind player thus reducing their noise exposure. This attenuation is designed to reduce overall loudness and not create any apparent distortion in tonal perception.

Measurements

The measurements were carried out in the large anechoic chamber at NAL, a location where noise is strictly controlled and there can be no background noise interference. The test signal was supplied by a ‘pink’ noise source, a source that produces noise evenly spread across all frequencies at a level of about 80 dB. The measurements were made with the sound source located 1.0 m on the opposite side of the Goodear to the microphone. A measurement was made with and without the Goodear present, the attenuation provided by the Goodear being the difference between the two readings.

Measurements were conducted with the microphone located at three positions on the user side of the Goodear, 1 cm, 10cm and 20 cm, to represent different possible locations of the ears. The measurements made were A-weighted, C-weighted and Z-weighted (un-weighted) equivalent continuous sound pressure level (L_{Aeq} dB). The different weightings were used for interest and to compare any frequency characteristics of the device. The A-weighting represents hearing characteristics of the ‘average’ human ear.

One of the benefits of using the Goodear as compared to identically sized acoustic shields made from clear, hard ‘plastic’ materials is that is does not reflect any incident sound to adjacent musicians. This means that there should be no spurious sound sources inadvertently set up within the orchestra, and increase in the sound exposure of adjacent players is not affected by the use of the Goodear. To test this hypothesis, measurements were taken at positions adjacent to the test sound source representative of where adjacent musicians may be located.

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Results

The attenuation of the Goodear was determined to be approximately 8 dB when measured directly behind the shield in the normal use position. Because of the non-linear nature of the decibel scale, a 3 dB attenuation in sound level represents a 50% reduction in sound exposure. Thus an attenuation of 8 dB results in an 84% reduction in the sound exposure. This reduction in exposure is quite significant in terms of future hearing health as the risk of noise injury is proportional to the exposure level.

Measurements taken adjacent to the sound source in a position where an accompanying musician would be located showed that the use of an equivalent sound shield made of a hard, plastic material increases the sound level in the adjacent position by roughly 3 dB. In real terms this is equivalent to doubling the sound exposure for the adjacent musician(s).
The attenuation results with the clear, hard surfaced plastic material were very similar to the Goodear being only 1 dB less in attenuation at the measured positions. The exception was for the reflected position with the microphone located to the right hand side of the sound source. In this case the clear plastic shield produced an increase in the measured level of up to 4 dB while the Goodear produced no apparent change in level.

Conclusion

The results gathered here show that the use of the Goodear can easily reduce the sound exposure of musicians by more than a factor of four compared to non-use. Use of shields which are constructed of hard reflective materials will decrease exposure levels for the 'protected' musician in a similar manner to the Goodear but will noticeably increase the exposure for the musician located adjacent to the sound source.

G Stewart
W Williams
August 4th, 2011

Equipment list

B&K 2250 Sound Level Meter, S/N2611535 with NATA traceable calibration (Nov-2011)
B&K 4189 Microphone, S/N2607684 with NATA traceable calibration (Nov-2011)
B&K 4231 Sound Level Calibrator, S/N2095393 with NATA traceable calibration, (Feb-2012)

Attachment

Appendix -*Detailed test results*

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Appendix -*Detailed test results*

	Goodear at 1M with 1cm Microphone gap	No Goodear at 1.01M	attenuation	Clear plastic at 1M with 1cm Microphone gap	No plastic at 1.01M	attenuation	Goodear at 1M with 10cm Microphone gap	No Goodear at 1.10M	attenuation	Clear plastic at 1M with 10cm Microphone gap	No plastic at 1.10M	attenuation	Goodear at 1M with 20cm Microphone gap	no Goodear at 1.20M	attenuation	Clear plastic with Microphone at 1M RHS to speaker	No plastic Reflex	change
Frequency	LZeq	LZeq		LZeq	LZeq		LZeq	LZeq		LZeq	LZeq		LZeq	LZeq		LZeq	LZeq	
12.5Hz	18.94	20.37	1.43	31.92	20.37	-11.55	20.39	24.31	3.92	22.18	23.01	0.83	19.57	21.81	2.24	26.37	22.4	-4
16Hz	15.58	16.12	0.54	22.04	16.12	-5.92	16.96	22.51	5.55	18.15	15.86	-2.29	16.84	17.92	1.08	23.59	19.05	-4.5
20Hz	14.89	16.54	1.65	18.99	16.54	-2.45	16.47	20.64	4.17	16.64	15.76	-0.88	16.4	15.01	-1.39	20.7	17.62	-3.1
25Hz	12.3	13.33	1.03	13.76	13.33	-0.43	13.36	17.42	4.06	15.66	13.4	-2.26	12.53	13.13	0.6	17.29	19.16	1.87
31.5Hz	22.79	25.13	2.34	24.04	25.13	1.09	24.58	24.24	-0.34	25.36	24.48	-0.88	22.87	23.79	0.92	23.54	24.56	1.02
40Hz	37.37	38.85	1.48	38.1	38.85	0.75	36.61	37.68	1.07	37.9	38.4	0.5	37.23	37.45	0.22	38	38.31	0.31
50Hz	50.84	51.82	0.98	51.3	51.82	0.52	50.3	51.48	1.18	50.48	51.22	0.74	49.66	50.48	0.82	51.4	51.16	-0.2
63Hz	61.02	63.05	2.03	61.86	63.05	1.19	61.57	61.92	0.35	61.65	62.08	0.43	60.84	61.05	0.21	61.79	61.96	0.17
80Hz	65.25	66.97	1.72	66.08	66.97	0.89	65.06	65.82	0.76	65.51	66	0.49	64.75	64.62	-0.13	66.38	66.36	-0
100Hz	69.22	70.48	1.26	69.93	70.48	0.55	68.93	69.78	0.85	69.49	70.07	0.58	69.01	68.99	-0.02	69.66	69.75	0.09
125Hz	72.55	74.16	1.61	73.32	74.16	0.84	72.52	73.17	0.65	73.16	73.53	0.37	72.07	72.48	0.41	72.15	72.4	0.25
160Hz	75.33	76.22	0.89	75.73	76.22	0.49	75.08	75.6	0.52	75.54	75.94	0.4	75.22	74.46	-0.76	74.35	74.22	-0.1
200Hz	76.15	76.21	0.06	76.4	76.21	-0.19	76.3	76.47	0.17	76.18	76.11	-0.07	75.8	75.32	-0.48	74.22	74.1	-0.1
250Hz	75.62	75.55	-0.07	75.5	75.55	0.05	75.67	75.33	-0.34	75.26	74.81	-0.45	75.14	74.54	-0.6	72.08	71.95	-0.1
315Hz	70.22	70.05	-0.17	69.98	70.05	0.07	70.1	69.26	-0.84	70	69.17	-0.83	70.12	68.54	-1.58	64.83	64.62	-0.2
400Hz	73.94	74.04	0.1	73.9	74.04	0.14	74.15	73.64	-0.51	74.32	73.04	-1.28	74.27	72.47	-1.8	69.8	69.94	0.14
500Hz	73.72	76.16	2.44	73.69	76.16	2.47	74.46	76.03	1.57	74.5	75.28	0.78	75.25	75.22	-0.03	72.11	71.14	-1
630Hz	68.93	77.39	8.46	69.03	77.39	8.36	70.68	76.94	6.26	70.95	76.81	5.86	73.69	76.1	2.41	72.39	72.45	0.06
800Hz	72.42	78.8	6.38	73.69	78.8	5.11	70.75	78.51	7.76	71.53	77.98	6.45	71.85	78.03	6.18	71.82	70.16	-1.7
1kHz	75.03	79.58	4.55	73.64	79.58	5.94	73.71	79.28	5.57	74.03	78.7	4.67	68.02	78.66	10.64	71.62	70.12	-1.5
1.25kHz	67.81	75.49	7.68	64.95	75.49	10.54	70.99	75.22	4.23	66.97	74.56	7.59	70.85	74.56	3.71	69.82	68.18	-1.6
1.6kHz	68.19	76.56	8.37	66.59	76.56	9.97	65.21	76.15	10.94	63.75	75.77	12.02	72.23	75.31	3.08	70.89	68.32	-2.6
2kHz	64.18	77.51	13.33	66.31	77.51	11.2	67.97	77.12	9.15	62.7	76.7	14	65.29	76.42	11.13	70.89	64.77	-6.1
2.5kHz	62.8	76.15	13.35	65.24	76.15	10.91	63.27	75.84	12.57	60.5	75.4	14.9	67.75	75.13	7.38	70.34	64.34	-6
3.15kHz	60.97	76.67	15.7	67.34	76.67	9.33	63.64	76.31	12.67	65.41	75.81	10.4	66.99	75.69	8.7	72.19	65.94	-6.3
4kHz	57	75.14	18.14	63.69	75.14	11.45	59.76	74.83	15.07	65.54	74.23	8.69	61.82	74.17	12.35	71.12	60.38	-11
5kHz	54.8	74.92	20.12	61.16	74.92	13.76	56.22	74.56	18.34	62.31	74.11	11.8	59.87	73.88	14.01	71.88	54.73	-17
6.3kHz	53.79	76.11	22.32	63.6	76.11	12.51	53.92	75.75	21.83	59.06	74.95	15.89	58.11	75.05	16.94	71.97	54.05	-18
8kHz	54.14	73.57	19.43	59.27	73.57	14.3	50.16	73.23	23.07	59.63	72.82	13.19	52.52	72.55	20.03	70.41	51.07	-19
10kHz	53.63	75.25	21.62	59.09	75.25	16.16	52.66	74.8	22.14	59.63	74.31	14.68	49.02	74.15	25.13	69.17	49.17	-20
12.5kHz	48.65	72.3	23.65	52.48	72.3	19.82	52.77	71.75	18.98	56.74	71.35	14.61	51.35	71.18	19.83	64.92	44.49	-20
16kHz	41.41	68.81	27.4	42.76	68.81	26.05	48.81	68.28	19.47	52.94	67.89	14.95	49.78	67.74	17.96	59.26	38.9	-20
20kHz	36.83	63.14	26.31	41.95	63.14	21.19	38.71	62.44	23.73	44.82	62.2	17.38	41.49	61.93	20.44	51.97	35.15	-17
A	**80**	**88**	**8**	**81**	**88**	**8**	**80**	**88**	**8**	**80**	**87**	**7**	**81**	**87**	**6**	**83**	**79**	**-4**
C	**84**	**89**	**5**	**85**	**89**	**4**	**84**	**89**	**4**	**84**	**88**	**4**	**85**	**88**	**3**	**84**	**83**	**-2**
Un-weighted (Z)	**84**	**89**	**5**	**85**	**89**	**5**	**85**	**89**	**5**	**85**	**89**	**4**	**85**	**88**	**4**	**85**	**83**	**-2**
	Goodear at 1M with 1cm Microphone gap	No Goodear at 1.01M	attenuation	Clear plastic at 1M with 1cm Microphone gap	No plastic at 1.01M	attenuation	Goodear at 1M with 10cm Microphone gap	No Goodear at 1.10M	attenuation	Clear plastic at 1M with 10cm Microphone gap	No plastic at 1.10M	attenuation	Goodear at 1M with 20cm Microphone gap	no Goodear at 1.20M	attenuation	Clear plastic with Microphone at 1M RHS to speaker	No plastic present	increase in level