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Sound pressure measurement of AVAS system in hemi-anechoic chamber with different sound source conditions (1 appendix)

Client

SoundRacer AB

Test object

SoundRacer Electric Vehicle Sound Module: EVSMA-1
SoundRacer Speaker: EVSP31

Date of test

May 31, 2018

Assignment

RISE has been commissioned to document the possibilities of the SoundRacer Electric Vehicle Sound System to meet the requirements of noise levels in the AVAS (Acoustic Vehicle Alerting System) legislation. The requirements are stated in UN (ECE) Regulation No. 138 Quiet Road Transport Vehicles.

Method

The sound pressure was measured with A-weighted max overall level and A-weighted one-third-octave frequency resolution from 160 Hz to 5 kHz according to ECE R138 Rev1. Every measurement lasted for 30 seconds. Measurements were performed indoors in a hemi-anechoic room with the size 4,9 x 5,5 x 3,9 = 106 m³. The room complies with the requirements of ISO 3745 within the frequency range 80 - 20 000 Hz. Measurement distance 2,0 m. The speaker and microphone were placed on stands 1,2 m over a reflecting plan.

Note. According to ECE R138 the tests shall be performed with the AVAS system mounted in a vehicle. This has not been done.



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Result

The result shows that the system has a good possibility of meeting the minimum sound pressure requirements at 10 and 20 km/h respectively. However, several of the measurements on idle mode do not reach up to minimum levels (10 and 20 km/h requirements). Multiple settings of the test object exceeds the maximum permissible sound pressure level of 75 dBA.

Measured A-weighted sound pressure levels at various setting of the test object are given in table 1. The corresponding required minimum and maximum levels according to ECE R138 Rev 1 are given in table 2. For 1/3 octave result, see appendix 1.

Table 1. Result, sound pressure level L_{pAFmax} dB

Engine sound	Setting	Overall Sound pressure level L_{pAFmax} dB (dBA)						Engine brake
		Idling	Level 2	Level 3	Level 4	Level 5	Level 6	
4-cyl	100/100/100	55	69	74	79	80	80	-
4-cyl	100/80	55	67	73	78	78	79	76
V8	60/100	63	77	81	80	80	82	-
Lamborghini V10	60/100	59	81	83	87	88	88	-
Ferrari	60/100	69	78	82	86	87	90	-
HD	60/100	68	77	78	82	83	82	80

Table 2, Requirements for overall sound pressure level according to ECE R138

Overall requirements in dBA			
Min reversing	Min 10 km/h	Min 20 km/h	Max forward
47	50	56	75

Operating and mounting conditions

The analog input was alternated between 6 levels to simulate different engine speeds using the EVSMA-1 sound module. The settings and volume was operated by the client. See picture 1. The speaker was mounted on a piece of wood attached to a stand. See picture 2.

Picture 1. Photo of the EVSMA-1 Sound Module



Picture 2. Photo of the speaker EVSP-31



Measurement uncertainty

For this engineering method, a value of the standard deviation of reproducibility is equal to or less than 1.5 dB. The expanded measurement uncertainty is ± 3 dB with a coverage factor of two which provides a level of confidence of approximately 95 %. The expanded uncertainty as described in this International Standard does not include the standard deviation of production.

Instrumentation

Instrument	Manufacturer	Type	Internal no
Noise level meter	Norsonic	140	901193
Sound level calibrator	Bruel & Kjaer	4231	502351

RISE Research Institutes of Sweden AB Building Technology - Sound and vibration

Performed by

Examined by

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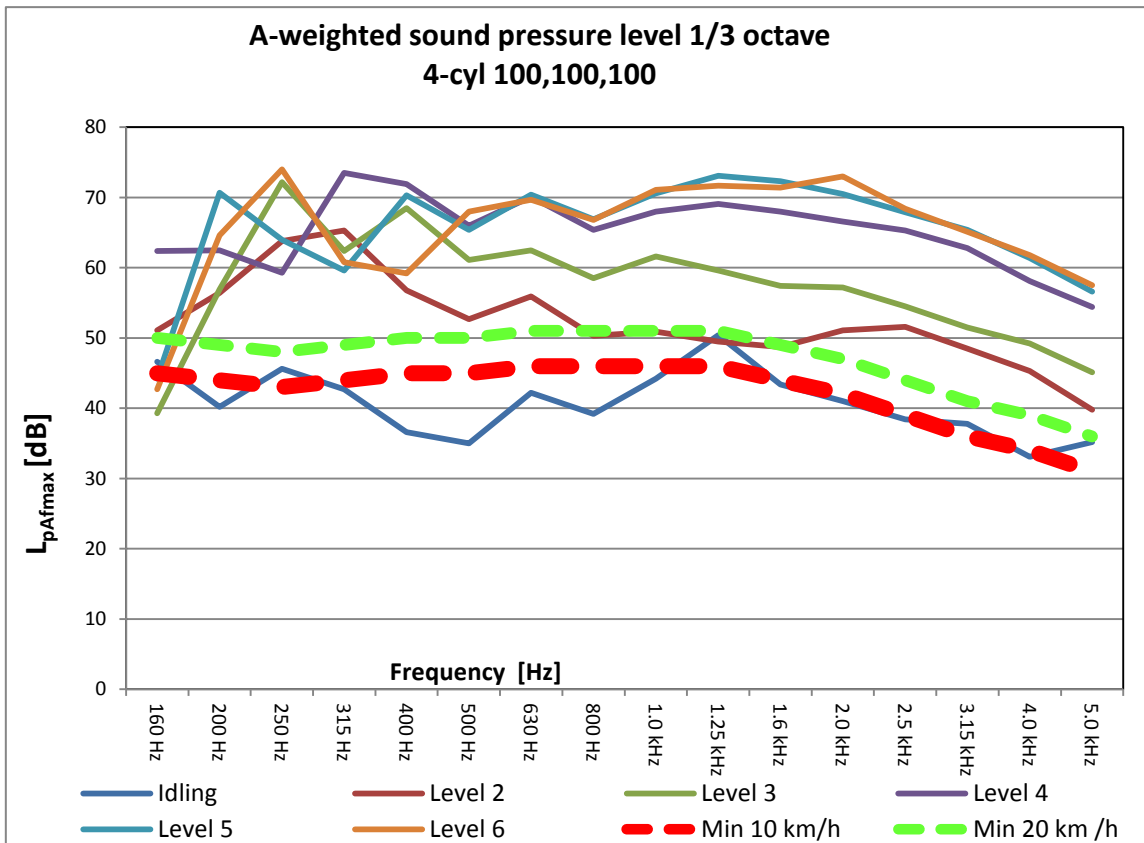
Appendix

Appendix 1

4-cylinder engine. Setting: 100/100/100.

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6
160 Hz	45	50	47	51	39	62	44	43
200 Hz	44	49	40	56	57	63	71	65
250 Hz	43	48	46	64	72	59	64	74
315 Hz	44	49	43	65	62	74	60	61
400 Hz	45	50	37	57	69	72	70	59
500 Hz	45	50	35	53	61	66	65	68
630 Hz	46	51	42	56	63	70	70	70
800 Hz	46	51	39	50	59	65	67	67
1.0 kHz	46	51	44	51	62	68	71	71
1.25 kHz	46	51	50	50	60	69	73	72
1.6 kHz	44	49	43	49	57	68	72	71
2.0 kHz	42	47	41	51	57	67	71	73
2.5 kHz	39	44	38	52	55	65	68	68
3.15 kHz	36	41	38	49	52	63	65	65
4.0 kHz	34	39	33	45	49	58	61	62
5.0 kHz	31	36	35	40	45	54	57	58

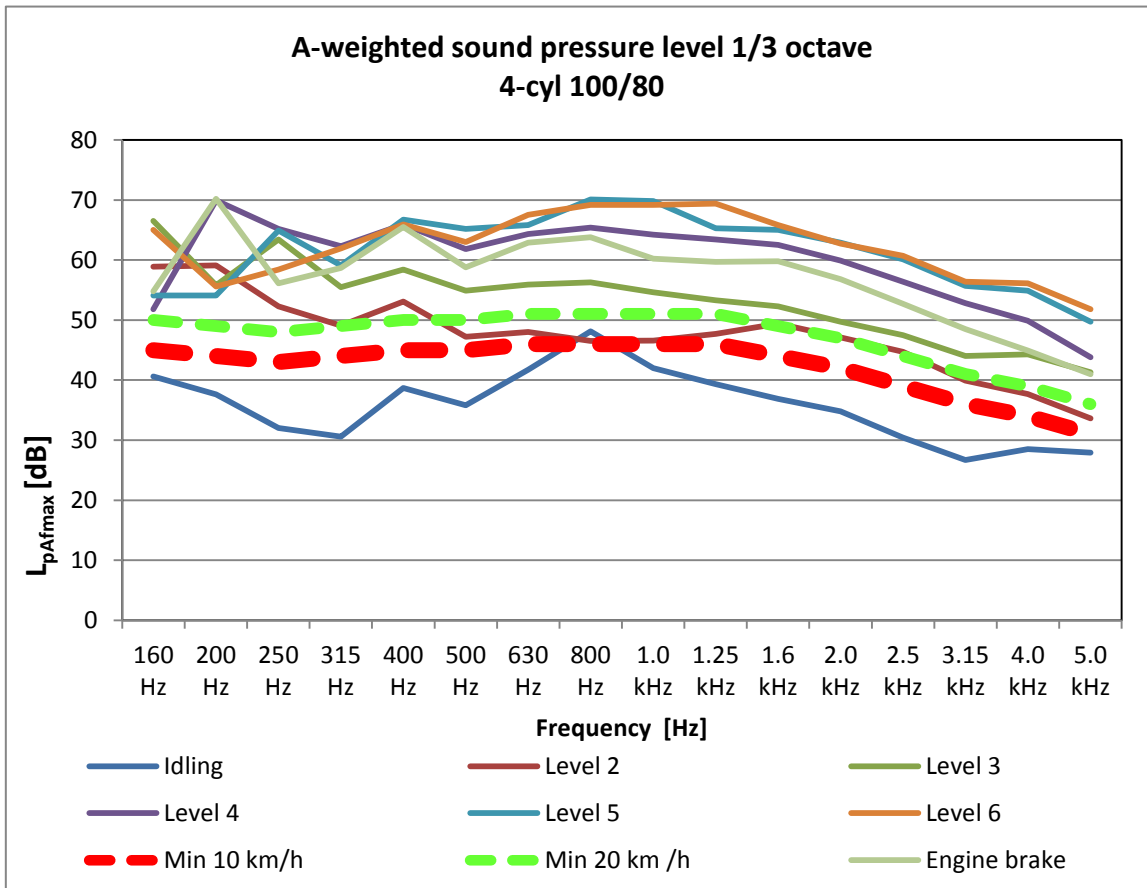


Appendix 1

4-cylinder engine. Setting: 100/80

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6	Engine brake
160 Hz	45	50	41	59	67	52	54	65	55
200 Hz	44	49	38	59	56	70	54	56	70
250 Hz	43	48	32	52	63	65	65	58	56
315 Hz	44	49	31	49	56	62	59	62	59
400 Hz	45	50	39	53	58	66	67	66	66
500 Hz	45	50	36	47	55	62	65	63	59
630 Hz	46	51	42	48	56	64	66	68	63
800 Hz	46	51	48	47	56	65	70	69	64
1.0 kHz	46	51	42	47	55	64	70	69	60
1.25 kHz	46	51	39	48	53	63	65	69	60
1.6 kHz	44	49	37	49	52	63	65	66	60
2.0 kHz	42	47	35	47	50	60	63	63	57
2.5 kHz	39	44	30	45	48	56	60	61	53
3.15 kHz	36	41	27	40	44	53	56	56	49
4.0 kHz	34	39	29	38	44	50	55	56	45
5.0 kHz	31	36	28	34	41	44	50	52	41

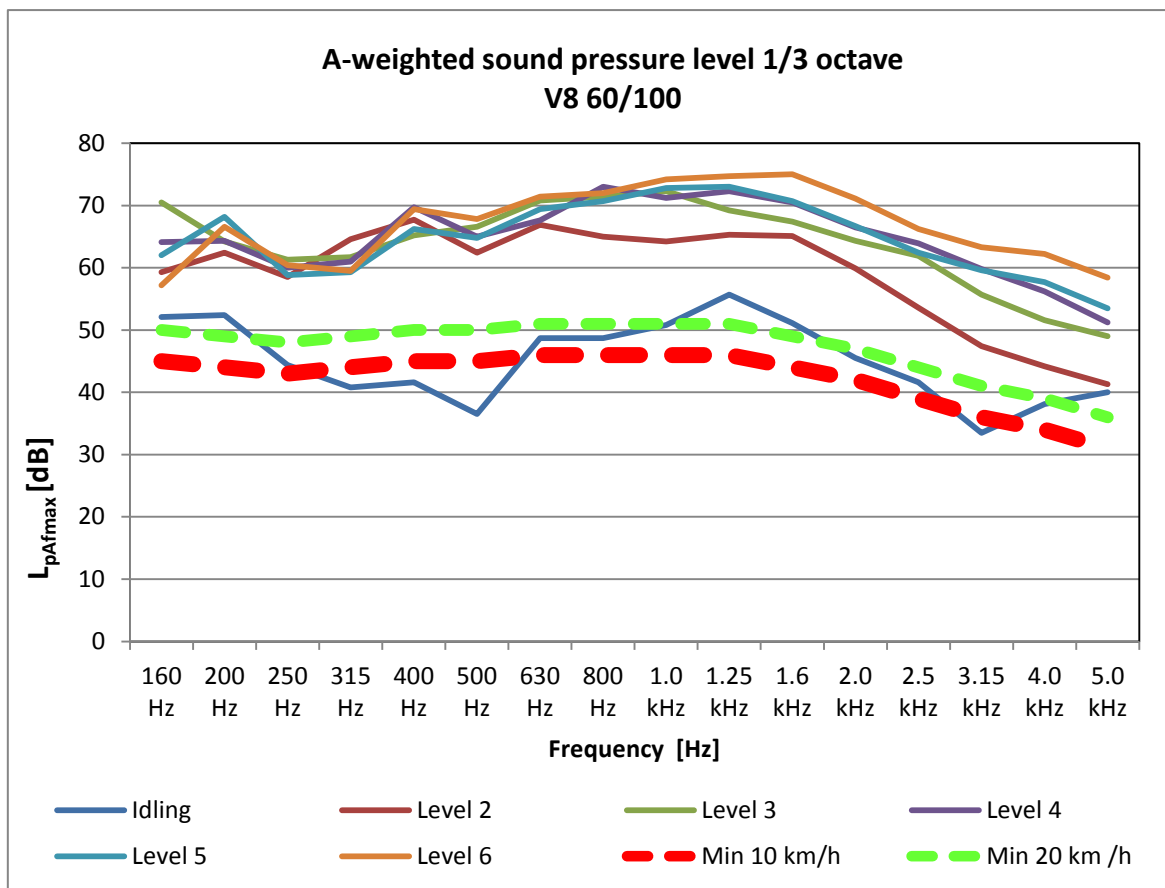


Appendix 1

V8 engine. Setting: 60/100

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6
160 Hz	45	50	52	59	71	64	62	57
200 Hz	44	49	52	62	64	64	68	67
250 Hz	43	48	44	59	61	60	59	60
315 Hz	44	49	41	65	62	61	59	60
400 Hz	45	50	42	68	65	70	66	69
500 Hz	45	50	37	62	67	65	65	68
630 Hz	46	51	49	67	71	68	69	71
800 Hz	46	51	49	65	71	73	71	72
1.0 kHz	46	51	51	64	72	71	73	74
1.25 kHz	46	51	56	65	69	72	73	75
1.6 kHz	44	49	51	65	67	71	71	75
2.0 kHz	42	47	46	60	64	67	67	71
2.5 kHz	39	44	42	54	62	64	62	66
3.15 kHz	36	41	34	47	56	60	60	63
4.0 kHz	34	39	38	44	52	56	58	62
5.0 kHz	31	36	40	41	49	51	54	58

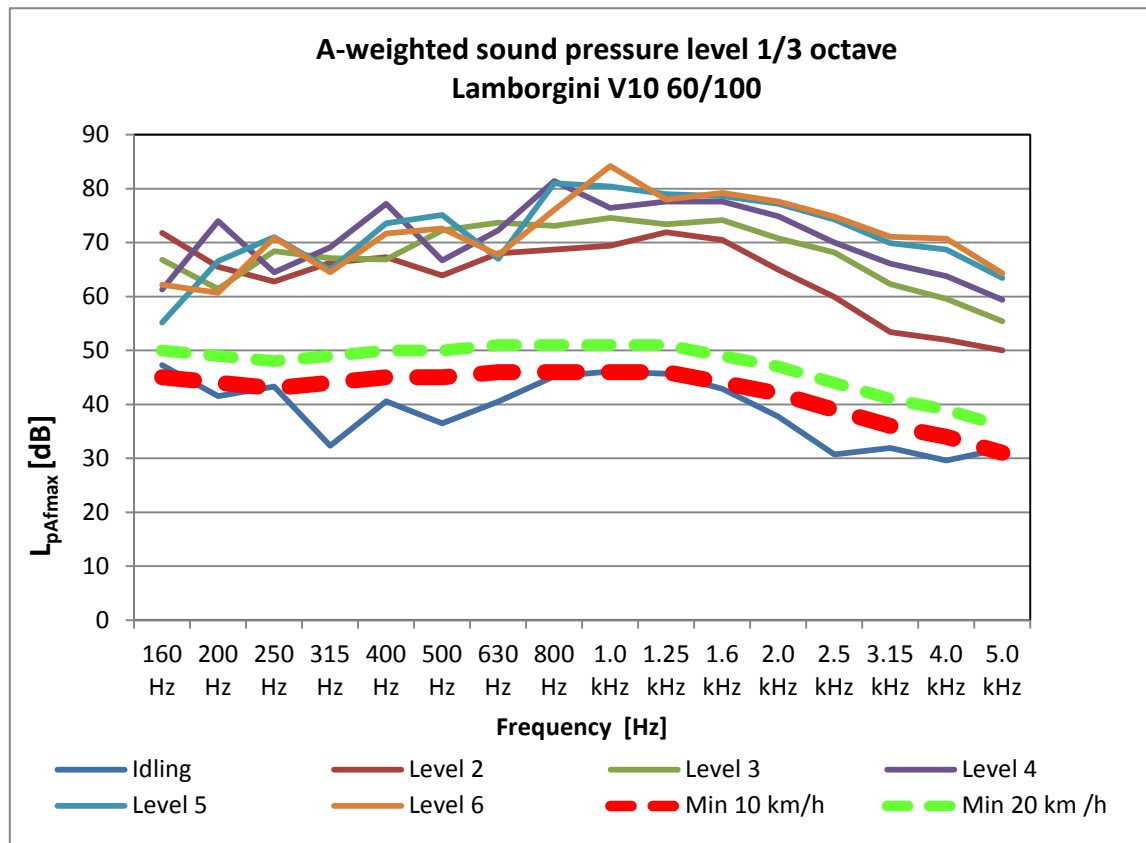


Appendix 1

Lamborghini V10. Setting: 60/100

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6
160 Hz	45	50	47	72	67	61	55	62
200 Hz	44	49	42	66	61	74	67	61
250 Hz	43	48	43	63	68	65	71	71
315 Hz	44	49	32	66	67	69	65	65
400 Hz	45	50	41	67	67	77	74	72
500 Hz	45	50	37	64	72	67	75	73
630 Hz	46	51	41	68	74	72	67	68
800 Hz	46	51	45	69	73	81	81	76
1.0 kHz	46	51	46	69	75	76	80	84
1.25 kHz	46	51	46	72	73	78	79	78
1.6 kHz	44	49	43	71	74	78	79	79
2.0 kHz	42	47	38	65	71	75	77	78
2.5 kHz	39	44	31	60	68	70	74	75
3.15 kHz	36	41	32	53	62	66	70	71
4.0 kHz	34	39	30	52	60	64	69	71
5.0 kHz	31	36	32	50	55	59	63	64

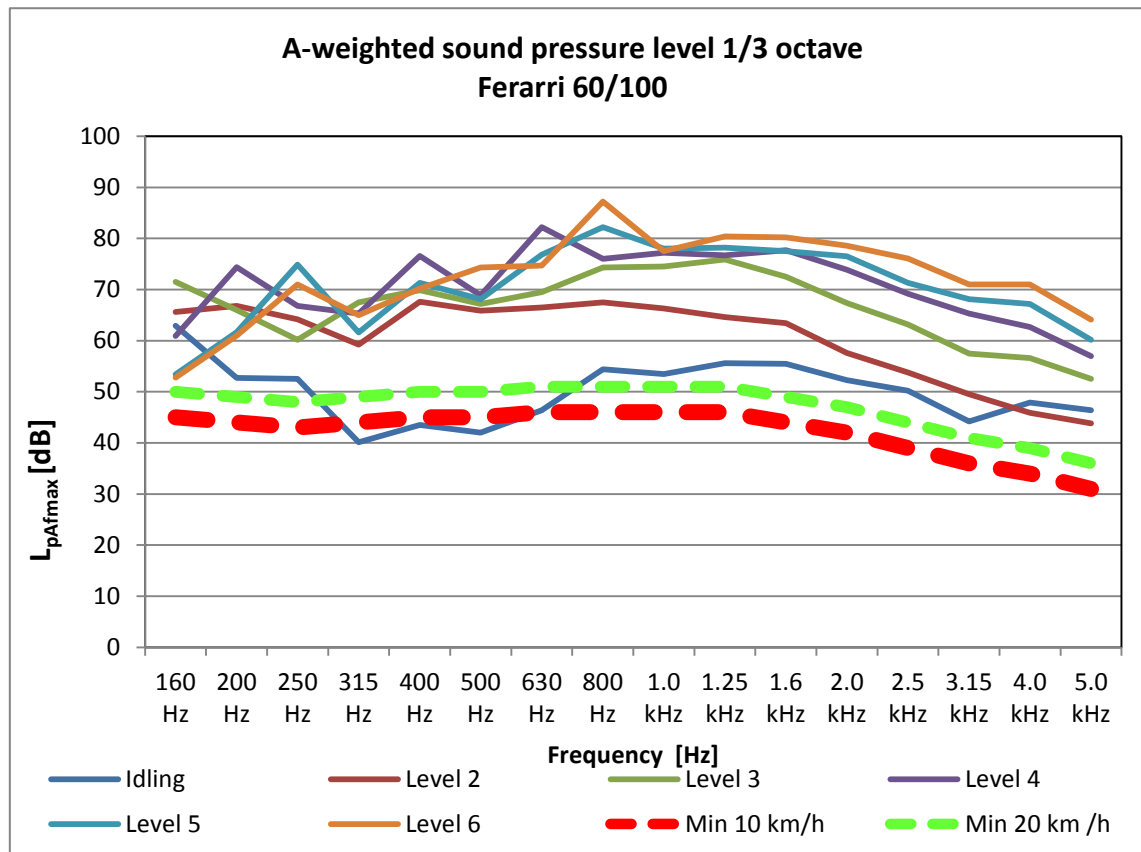


Appendix 1

Ferrari. Setting: 60/100

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6
160 Hz	45	50	63	66	72	61	53	53
200 Hz	44	49	53	67	66	74	62	61
250 Hz	43	48	53	64	60	67	75	71
315 Hz	44	49	40	59	68	65	62	65
400 Hz	45	50	44	68	70	77	71	70
500 Hz	45	50	42	66	67	69	68	74
630 Hz	46	51	46	67	70	82	77	75
800 Hz	46	51	54	68	74	76	82	87
1.0 kHz	46	51	54	66	75	77	78	78
1.25 kHz	46	51	56	65	76	77	78	80
1.6 kHz	44	49	56	63	73	78	78	80
2.0 kHz	42	47	52	58	67	74	77	79
2.5 kHz	39	44	50	54	63	69	71	76
3.15 kHz	36	41	44	50	58	65	68	71
4.0 kHz	34	39	48	46	57	63	67	71
5.0 kHz	31	36	46	44	53	57	60	64



Appendix 1

Harley Davidson. Setting: 60/100

A-weighted sound pressure level 1/3 octave L_{pAFmax} dB

Frequency Hz	Limit min 10 km/h	Limit min 20 km/h	Idling	Level 2	Level 3	Level 4	Level 5	Level 6	Engine brake
160 Hz	45	50	40	63	61	63	61	62	68
200 Hz	44	49	42	57	66	72	70	60	67
250 Hz	43	48	42	54	66	69	72	72	64
315 Hz	44	49	41	56	57	66	63	67	65
400 Hz	45	50	51	61	61	71	72	70	64
500 Hz	45	50	46	57	61	60	66	69	60
630 Hz	46	51	52	58	64	63	63	67	64
800 Hz	46	51	58	61	65	68	71	67	67
1.0 kHz	46	51	56	66	64	70	70	72	68
1.25 kHz	46	51	61	69	66	71	74	71	69
1.6 kHz	44	49	64	70	69	72	73	72	71
2.0 kHz	42	47	60	68	69	71	72	71	70
2.5 kHz	39	44	57	66	68	70	71	71	69
3.15 kHz	36	41	60	62	66	70	70	69	68
4.0 kHz	34	39	60	63	66	70	73	72	66
5.0 kHz	31	36	51	57	61	64	68	68	61

