

Considerations for the design of the RD-ASEP control range

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UNECE RD-ASEP Meeting
December 9h-10th, 2025

The $v \cdot a$ performance criteria approximate to power to mass at urban speeds on flat road

- In urban speed, on a flat road, the force needed to accelerate the vehicle is mainly to counter its inertia
- With these considerations

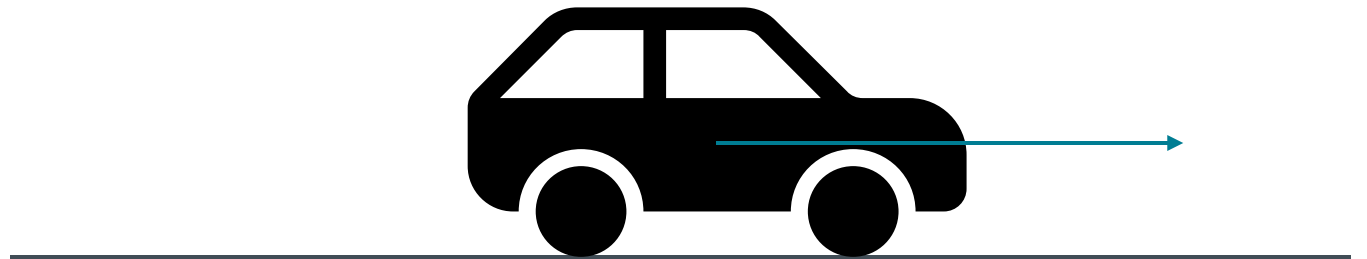
$$F = m \cdot a$$

$$\text{Power} = F \cdot v = m \cdot a \cdot v$$

$$\text{Power} / m = v \cdot a$$

The current limit of

$v \cdot a < 35 \text{ m}^2/\text{s}^3$ approximate to
35 kW/ton, or 47 HP/ton



Example from the RD-ASEP Excel Spreadsheet and sound model on a 66 kW

Vehicle Speeds		Engine Speed at line BB'	Reported Accelerator Position	SPL	SPL	Run Valid within Control Range	Space for comments by the test crew and/or technical service	Acceleration PP-BB'	Load	Vehicle Performance	Expected ROLLING Sound	Expected MECHANICAL Sound	Expected DYNAMIC Sound	Expected DELTA DYN Sound	AVAS Addition, if fitted	Expected OVERALL Sound
v_{pp}	$v_{bb'}$	$n_{bb'}$	%	L _{LEFT}	L _{RIGHT}	Auto Check (so not edit)		a_{TEST}	%	$v \cdot a$	L _{TR_EXP}	L _{PT_EXP}	L _{DYN_EXP}	ΔL_{DYN_EXP}	ΔL_{AVAS}	L _{EXP}
km/h	km/h	1/min		dB(A)	dB(A)			m/s ²			dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1st decimal	1st decimal	integer	%-value	1st decimal	1st decimal			2nd decimal	%-value	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal

Default examples

45.0	53.0	3600	55%	82.0		VALID		2.20	100%	32.5	70.1	68.5	51.3	30.5	0.0	84.3
55.0	59.6	2850	55%	76.0		VALID		1.48	100%	24.5	72.1	64.0	47.2	30.3	0.0	80.7
15.0	25.0	3120	55%	76.0		VALID		1.12	32%	7.8	63.0	65.7	48.7	26.5	0.0	77.9
80.0	80.0	3650	55%	79.0		VALID		0.00	0%	0.0	77.2	68.8	51.6	20.0	0.0	80.7
25.0	26.0	1250	55%	66.0		VALID		0.14	11%	1.0	63.4	54.5	39.3	23.0	0.0	68.2
55.0	60.0	4150	55%	83.5		VALID		1.62	84%	26.9	72.2	71.6	54.1	29.8	0.0	86.5
70.0	70.5	1500	55%	74.0		VALID		0.20	33%	3.9	75.0	55.6	40.2	26.6	0.0	77.7

Newly created examples

55.0	61.3	4480	60%	90.9		VALID	Within the control range	2.05	100%	35.0	72.6	73.4	55.8	30.7	0.0	88.9
55.0	63.5	5600	90%	97.1		VOID	Outside the control range, S is 100%, v*a >	2.83	100%	50.0	73.2	79.0	60.9	32.0	0.0	95.1
55.0	64.9	5800	100%	98.5		VOID	Outside the control range, S is 103.5%, v*a >	3.33	100%	60.0	73.6	79.9	61.7	32.6	0.0	96.5

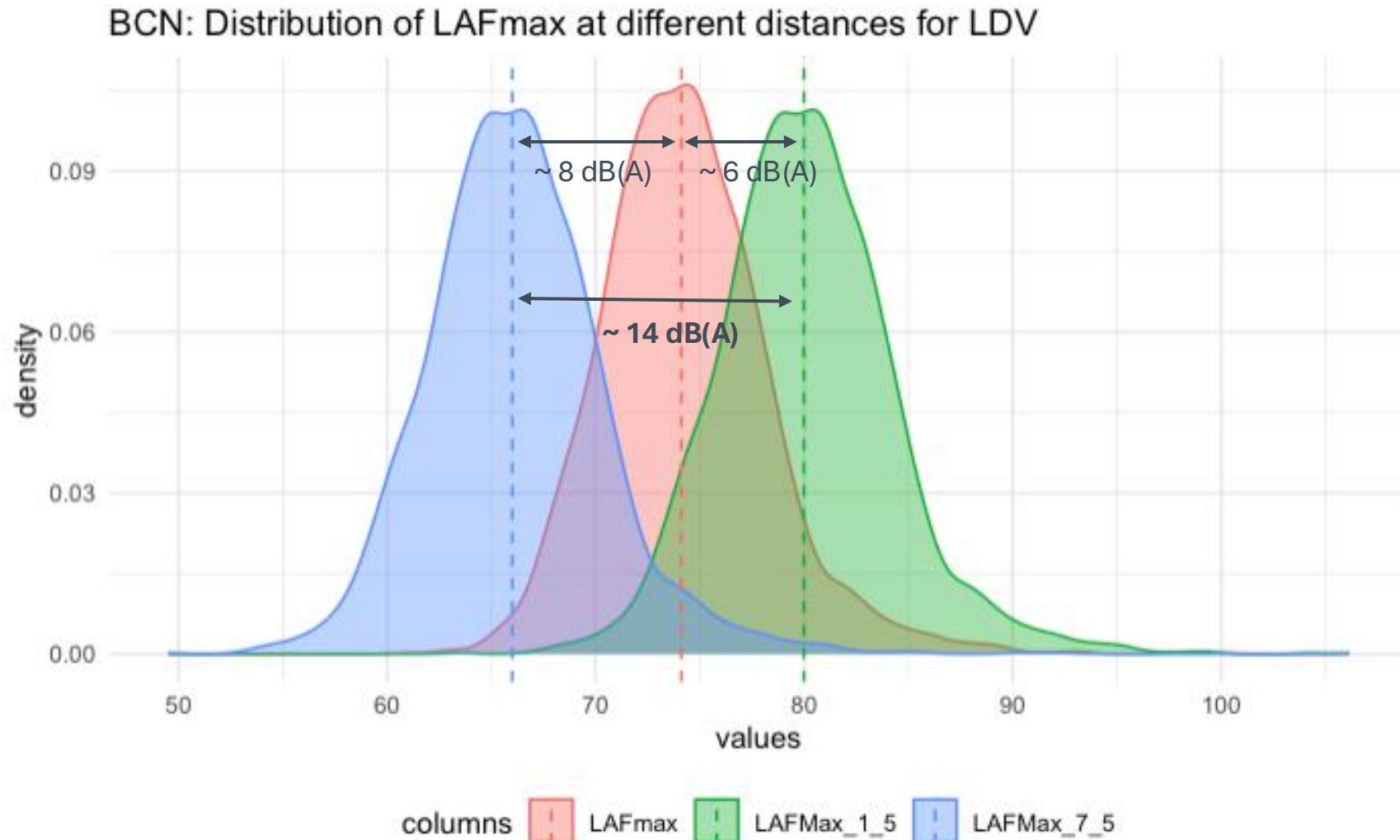
- Expected noise level within the control range gets close to 89 dB(A)
- Allowing the engine speed up to rated speed and $v \cdot a$ of 50 m²/s³ exceed 95 dB(A)
- Expanding beyond the rated speed and within achievable $v \cdot a$ for this car simulates higher noise (e.g. 96.5 dB(A))

Example from the RD-ASEP Excel Spreadsheet and sound model on a compact sports car (150 kW)

Start Point Acceleration (pre-acceleration length)	Vehicle Speeds			Engine Speed at line BB'	Reported Accelerator Position	SPL	SPL	Run Valid within Control Range	Space for comments by the test crew and/or technical service	Acceleration PP'-BB'	Load	Vehicle Performance	Expected ROLLING Sound	Expected MECHANICAL Sound	Expected DYNAMIC Sound	Expected DELTA DYN Sound	AVAS Addition, if fitted	Expected OVERALL Sound
						Left Side	Right Side											
	L	V _{AA'}	V _{BP'}	V _{BB'}	n _{BB'}	%	L _{LEFT}											
m	km/h	km/h	km/h	1/min	%-value	dB(A)	dB(A)		m/s ²	%-value	m ² /s ³	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1st decimal	1st decimal	1st decimal	1st decimal	integer	%-value	1st decimal	1st decimal		2nd decimal	%-value	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal	1st decimal
5.0	20.0	22.0	40.0	5000	100%	90.2		VALID	Within the control range	3.14	90%	34.9	67.1	76.1	58.2	30.4	0.0	90.9
5.0	30.0	40.0	48.0	5500	55%	91.0		VALID	Within the control range	1.98	62%	26.4	68.7	78.5	60.4	28.8	0.0	91.6
5.0	30.0	32.6	45.2	5600	55%	92.0		VALID	Within the control range	2.76	80%	34.6	68.2	79.0	60.9	30.0	0.0	93.1
5.0	30.0	42.3	53.5	6300	90%	99.3		VOID	Outside the range, S is 90%, v*a < 55	3.02	92%	44.8	70.2	82.2	63.8	31.3	0.0	97.3
5.0	30.0	35.4	51.1	7000	100%	103.0		VOID	Outside the range, S is 100%, v*a < 55	3.82	100%	54.2	69.4	85.2	66.5	32.3	0.0	101.0

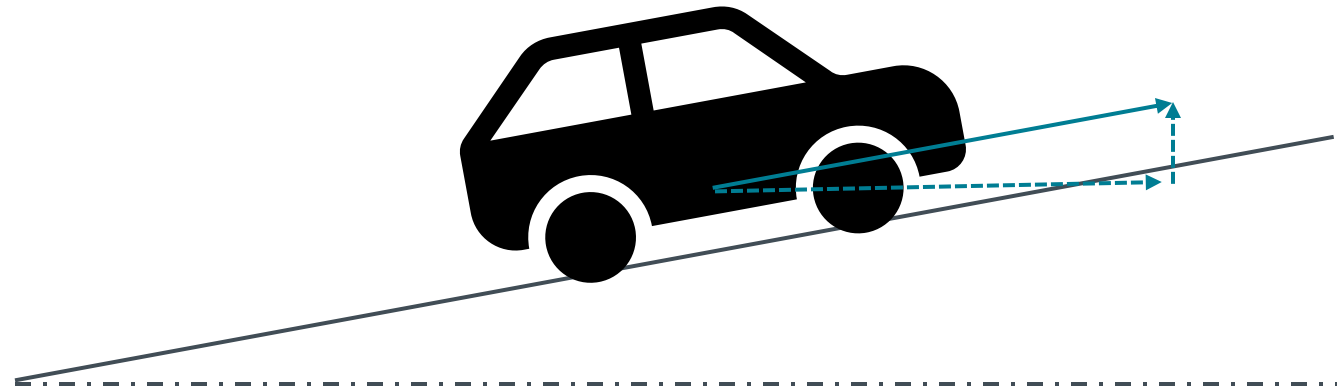
- Setting a simulated vehicle of 150 kW, with a mass of 1.360 kg and rated engine speed S of 7000 rpm
- Expected noise level within the control range can exceed 93 dB(A)
- With the engine speed of 100% of rated speed and v*a of 55 m²/s³, over 101 dB(A) expected
- The car is likely capable of a v*a > 100 m²/s³ at these speeds

In reality, pedestrians in urban areas are exposed to higher noise levels than type-approval levels



Consideration on the effect of the control range during uphill driving

- The WLTC was developed using speed and acceleration from field data. However, no engine data was used to translate torque demand, for instance during hilly driving, in a more ambitious target speed profile.
- $v \cdot a$ performance criteria on a flat road translates into higher engine power demand during uphill driving, corresponding to a higher equivalent performance criteria on a flat road when factoring in the impact of elevation



Road grade %	Speed (km/h)	Longitudinal acceleration (m/s ²)	a – Gravitational component (m/s ²)	$v \cdot a$ (longitudinal)	$v \cdot a$ equivalent
0%	50	2.52	0.00	35	35
5%	50	2.52	0.49	35	42
15%	50	2.52	1.46	35	55

Summary and discussions

- Example from the RD-ASEP Excel Spreadsheet and sound model on a 66 – 150 kW car models seems to indicate cases with modeled noise:
 - up to approx. 89 – 93 dB(A) within the control range
 - > 95 – 101 dB(A) outside the control range

Are these results in line with the group's expectations?

- The effect of the uphill driving conditions on noise should be considered, as these can lead to shift to lower gear, therefore higher engine rpm, and dynamic conditions more frequently exiting the noise-regulated control range defined on a flat road

Thank you for your attention!

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