Forschungsgesellschaft für
Verbrennungskraftmaschinen und
Thermodynamik mbH

Experimental Noise Source Ranking Study

Part 1

Measurements according to UNECE-R 41.04. / Annex 3

By order of

ACEM

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Experimental Noise Source Ranking Study Part 1 (ANNEX 3)

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1. Project targets

Noise emitted from motorized vehicles is one of the major annoying and negative impacts on the environment and the citizens. Actually, discussions about noise from motorized two wheelers are getting in the focus of various stakeholder from citizens' initiative to politics and future legislative regulations might tighten the already stringent noise limits.

In order to assess the actual status of noise emitted from motorized two wheelers an experimental study was carried out, in which the major noise sources are assessed according to their contribution to the overall level of pass-by noise for several two-wheeler vehicles.

A noise measurement study for the assessment and contribution of

- Intake noise
- Engine noise
- Exhaust noise
- Overall noise

was carried out by conducting measurements according to:

Standardized pass-by noise measurement procedure as regulated by UNECE-R 41.04. / Annex 3

In order to identify the contribution of the mentioned noise sources to the overall noise level a masking of the relevant and related noise emitting parts in 3 steps was performed followed by pass-by measurements in masked and un-masked condition. By subtracting the dedicated noise levels a mapping of the noise emissions to the 4 major sources was done.

- Cover stage 3: Vehicle with cover / damping: exhaust noise, intake noise, engine
- Cover stage 2: Vehicle with cover / damping: exhaust noise, intake noise
- Cover stage 1: Vehicle with cover / damping: exhaust noise
- Cover stage 0: Pure vehicle without cover / damping

2. Report Content

- Measurement Setup

  Description of the technical devices, procedures and regulations which were applied for the measurements.

- Vehicle Damping and Encapsulation Measures

  List and description for the measures which have been taken in order to separate the different noise sources on the vehicles.

- Measurement results

  Presentation of the measurement results in table and chart for each vehicle in condensed form. The measurement data were processed to deliver the contribution of the main noise sources to the overall noise level. For each vehicle the overall L_{urban} noise level is reported for the original version without any damping measures as well as the main noise source contributions over the test rack length for each vehicle side.

3. Measurement Setup

3.1. Measurement devices

B&K Pass-By Noise Measurement System

Vehicle Speed & Position System Race Logic

3.2. Measurement procedure

The following measurement procedure was used during the tests:

1. Ambient noise measurement
2. Test run(s) for correct speed signal and to determine entry speed and gear for each measurement point
3. Min 3 valid measurement runs for each measurement point
4. Ambient noise measurement

3.3. Distinction of component influence on the overall noise

By applying damping / encapsulation material in 3 steps, a distinction between 4 major noise contributions to the overall noise is possible, whereas this is subject to some restraints. First, no perfect encapsulation can be applied to all parts. For example, engine encapsulation is not perfect for the rear part of the engine, as the drivetrain exits this encapsulation at the rear. Second, no perfect damping is possible by the applied materials. Third, some parts have a combined noise contribution which cannot by separated. This applies for example for the drivetrain, tire and the remaining part of the vehicle, which have a common contribution.

3.4. Damping / Cover / Shield

4 different damping / cover variants were manufactured and fitted for each vehicle:

1. Naked: this is the standard version of the motorcycle without damping measures
2. Covered Engine:

Damping material was applied as rubber pad around the engine

3. Covered Engine & Exhaust: additionally, to “Covered Engine” the exhaust noise was damped by attaching a hose to the exhaust tail pipe leading to an additional big exhaust muffler, mounted on the rear of the vehicle
4. Covered Fully

3.5. Measurement data & measurement data calculation

Measurement data

The following data were acquired, calculated and logged during measurement:

- Vehicle Position via GPS
- Vehicle Speed via GPS
- Sound Pressure Level (SPL) [dB(A)/20µPa] for both vehicle sides
- Maximum hold spectra (1/3 Octave frequency band) for both sides
- Ambient noise

Test results ECE/324/Rev.1/Add.40/Rev.2 ANNEX 3

For each damping variant, a minimum of three test runs were performed delivering three Sound Pressure Level curves over the travelled path between measurement points AA-PP-BB (mean value calculation according to [1]). The maximum Sound Pressure Levels L are calculated for each side and processed further to a L_{urban} value for each damping variant according according ECE/324/Rev.1/Add.40/Rev.2 ANNEX 3.

Calculation of L_urban

The *L_urban* value was calculated according ECE/324/Rev.1/Add.40/Rev.2 ANNEX 3 (Equation 1)

$$L_{urban} = L_{wot} - kp * (L_{wot} - L_{crs})$$

(Equation 1)

Lwot, Lcrs

For the calculation of the sound pressure levels Lwot and Lcrs, the maximum A-weighted sound pressure level for each measurement was reduced by 1dB(A) and mathematically rounded to the nearest first decimal place for both microphone places. The resulting sound pressure levels for three measurements of each gear (i) and for acceleration (wot) and constant (crs) driving were averaged separately (Equation 2).

$$L_{mode,(i),side} = 1/3 * (L_{mode,(i),side,1} + L_{mode,(i),side,2} + L_{mode,(i),side,3})$$

(Equation 2)

The higher value of the two averages was mathematically rounded to the nearest first decimal place, resulting in $L_{wot,(i)}$ and $L_{crs,(i)}$.

Power-to-Mass Ratio PMR

The calculation of the *PMR* ((Equation 3) was based on the actual weight or the definition by the vehicle manufacturer. Although the vehicle weight increased from damping variant 0-4 reaching considerably more mass than tolerated in [1], the PMR was kept constant for all vehicle damping variants in order to allow a comparison. For each vehicle the actual test mass is noted in the section 4 Vehicles & Damping Measures.

$$PMR = (P_n / (m_{kerb} + 75))* 1000$$

(Equation 3)

Reference accelerations $a_{wot\ ref}$ and a_{urban}

The reference accelerations are based on the *PMR* ((Equation 4) and therefore constant for all vehicle damping variants.

$$a_{wot\ ref} = 2.47 * log(PMR) - 2.52 \text{ for vehicles with a PMR} \leq 50$$
$$a_{wot\ ref} = 3.33 * log(PMR) - 4.16 \text{ for vehicles with a PMR} > 50$$

$$a_{urban} = 1.37 * log(PMR) - 1.08 \text{ for vehicles with a PMR} \leq 50$$
$$a_{urban} = 1.28 * log(PMR) - 1.19 \text{ for vehicles with a PMR} > 50$$

(Equation 4)

Gear weighting factor k

In order to combine measurements of two gears (were indicated according to [1]) a gear weighting factor *k* is used. This factor was calculated for each vehicle damping variant based on the actual measurement values of the acceleration and therefore different for each variant.

Partial power factor k_p

The partial power factor *kp* is a dimensionless number used to combine the results of a full throttle acceleration test with those of a constant speed test. For two gear measurements *kp* is defined based on the actual acceleration and therefore changes with different vehicle damping variants.

Influence of changing vehicle mass on the calculation of L_{urban}

An exemplarily calculation of *L_urban* for the original OEM value PMR=163 and the value for damping/cover version: covered exhaust & engine (additional mass ~25kg) delivers a difference of 0,1 dB being 73,3 for the original PMR and 73,2 for the actual PMR. The test mass m_t as defined in [1] exceeded the regulated 75kg due to increased mass of the equipment.

Gear choice

The choice of the gear for measurement was done on the base of the OEMs definition. 3 Vehicles are equipped with an automatic transmission (CVT) without manual gear option and measured accordingly without fixed gear ratio. 1 Vehicle was measured in 3rd and 4th gear and 4 vehicles were measured in single gear.

Noise source differentiation

As the values according ECE/324/Rev.1/Add.40/Rev.2 ANNEX 3 give no information about the contribution of the single components (see below) a further calculation for noise source differentiation was performed. The averaged[1] sound pressure level curves for each damping variant are calculated and displayed and the maximum SPL extracted. In contrast to the ANNEX 3 calculation no subtraction of 1dB(A) was performed for these values.

With the above-described damping / cover measures several noise sources can be determined out of the measured data. As the measurement result is sound pressure level (SPL) in db(A) / 20µPa, a direct subtraction of the db(A) values is not physically correct. Instead, a back-calculation to absolute sound pressure, subtraction of sound pressures followed by conversion into db(A) / 20µPa is applied. With L_A being the sound pressure level of damping variant A and L_B being the sound pressure level of damping variant B, the difference of both, the sound pressure level of component 1 $L_{Influence1}$ becomes:

$$L_{influence\,1} = 10 * LOG(10^{L_A*0,1} - 10^{L_B*0,1})$$

[1] Three measurement runs were mathematically averaged

(Equation 5)

The following influences can be distinguished:

- Engine by subtraction of variant “covered engine” from “naked”
- Exhaust by subtraction of variant “covered engine & exhaust” from “covered engine”
- Intake by subtraction of variant “fully covered” from “covered engine & exhaust”
- Drive train, wheels, … = result of “fully covered”

The data, which can be found in the tables *“Table XX: Vehicle Name UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT left vehicle side”* (see e.g. Table 28) and the graphs “*“Figure XX: Vehicle Name UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT left vehicle side”* do not represent the SPL values of the single damping variants, but the noise contribution of the named components.

Theoretically, the SPL values should be decreasing with increased damping, resulting in the lowest value for the fully covered variant and the highest value for the original setting. In some cases, the SPL values of a subsequent damping variant are similar or even little higher than from the preceding variant. This can be caused by low repeatability of test runs, very little influence of the damping measures, influence of the damping measures itself on the noise result (wind noise) and influence of the increased gross vehicle weight on the noise. In these cases, the resulting component contribution was set to zero (e.g. Table 60). This applies for the graphs SPL component contribution over traveled path as well as for the max. SPL values.

3.6. Test Tracks

Two different test tracks were used for the measurement, both certified according to [1] and situated in / around Graz:

- Test track AVL

Figure 1: AVL Test Facility Gratkorn

- Test track Magna

Figure 2: Magna Steyr – Test facility Graz

4. Vehicles & Damping Measures

8 Vehicles have been provided by the vehicle manufacturers and investigated in the condition as delivered. The individual damping measures for exhaust-, intake- and engine-noise are displayed in this chapter for the tested vehicles in the order of Table 1.

Table 1: Tested vehicle in alphabetic order

Vehicle	Capacity	Engine Type	Transmission	Power
BMW R 1250 GS	1254 cm³	Boxer 2-cyl. liquid cooled	6-speed manual	100 kW
Harley Davidson Street Bob	1,745 cm³	V 2-cyl. air-cooled	6-speed manual	64 kW
Honda Forza 125	124.9 cm³	1 cyl. liquid cooled	CVT	10.7 kW
Kawasaki Vulcan S	649 cm³	In-line 2-cyl. liquid cooled	6-speed manual	44.7 kW
KTM 390 Duke	373 cm³	1 cyl. liquid cooled	6-speed manual	32 kW
Piaggio Vespa 300GT	278 cm³	1 cyl. liquid cooled	CVT	15.5 kW
Triumph Street Triple	765 cm³	In-line 3 cyl. liquid cooled	6-speed manual	86.8 kW
Yamaha T-Max	562 cm³	In-line 2-cyl. liquid cooled	CVT	35 kW

4.1. BMW R 1250 GS

Figure 3: BMW R 1250 GS

Measurement procedure:

The vehicle was measured in 4th gear according to the manufacture's definition.

Table 2: Technical specifications BMW R 1250 GS

Specs.		
Engine	2-cylinder, boxer liquid-cooled	1254 cm³
Performance	100 kW @ 7,750 rpm	143 Nm @ 6,250 rpm
PMR	309	249 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 3: Mass data of encapsulation variants BMW R 1250 GS

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 32,2
Exhaust damping & Engine encapsulation	+ 27,6
Exhaust damping	+ 15,1
Racelogic GPS equipment + Backpack	+ 3,5

Table 4: Part list with masses of additional material (damping, encapsulation, equipment) BMW R 1250 GS

Parts	Mass [kg]	Comment / Material
Total	32,2	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	11,6	
Exhaust muffler / oval big	8,9	incl. mounting
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	0,6	steel
Engine damping	12,5	
BMW engine covers	12,5	belts/soft/heavy
Intake damping	4,6	
BMW intake damping	4,6	cage/soft/heavy

Encapsulation variant: Fully encapsulated

Figure 4: Fully encapsulated version BMW R 1250 GS

Encapsulation variant: Engine & Exhaust damped

Figure 5: Engine & Exhaust damped version BMW R 1250 GS

Encapsulation variant: Exhaust damped

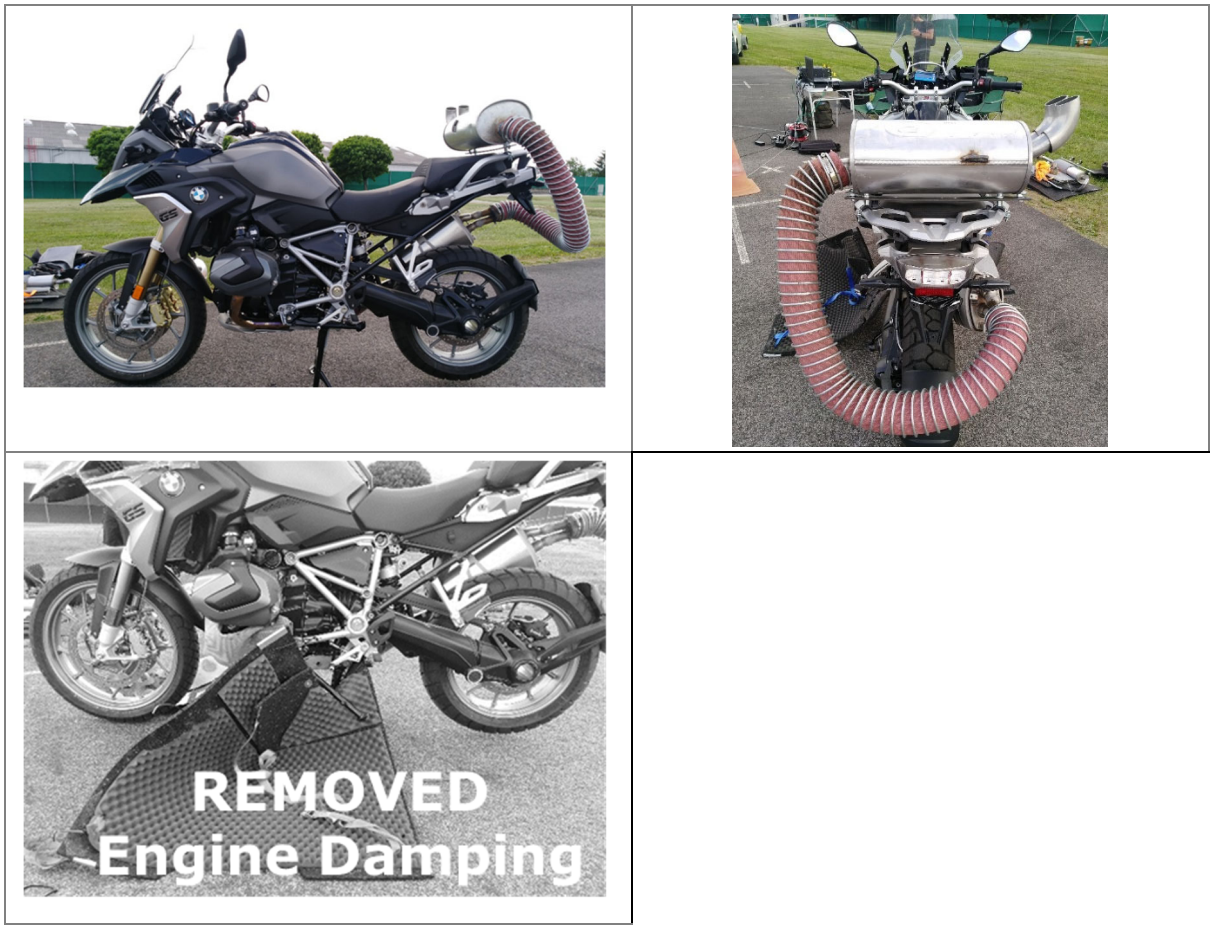

Figure 6: Exhaust damped version BMW R 1250 GS

Encapsulation variant: Original Setting

Figure 7: Original version BMW R 1250 GS

4.2. Harley Davidson Street Bob

Figure 8: Harley Davidson Street Bob

Measurement procedure:

The vehicle was measured in 3th and 4th gear according to the manufacture's definition.

Table 5: Technical specifications HD Street Bob

Specs		
Engine	V 2-cylinder, air-cooled	1,745 cm³
Performance	64 kW	155 Nm @ 3,250 rpm
PMR	172	297kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 6: Mass data of encapsulation variants HD Street Bob

Encapsulation Variant:	**Mass [kg]**
Fully Encapsuled / Damped	+ 35,1
Exhaust damping & Engine encapsulation	+ 31,5
Exhaust damping	+ 19,2
Racelogic GPS equipment + Backpack	+ 3,5

Table 7: Part list with masses of additional material (damping, encapsulation, equipment)
HD Street Bob

Parts	Mass [kg]	Comment / Material
Total	35,1	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	15,7	
Exhaust muffler / oval big	8,9	2 extra mounting parts
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	4,7	
Engine damping	12,3	
Engine covers	12,3	belts/soft/heavy
Intake damping	3,6	
Intake damping	3,6	vol/hose/adapt.

Encapsulation variant: Fully encapsulated

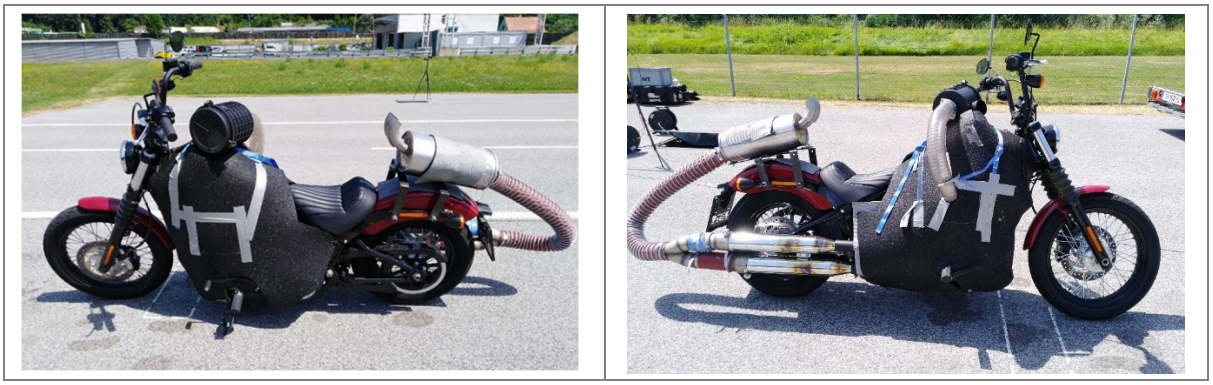

Figure 9: Fully encapsulated version HD Street Bob

Encapsulation variant: Engine & Exhaust damped

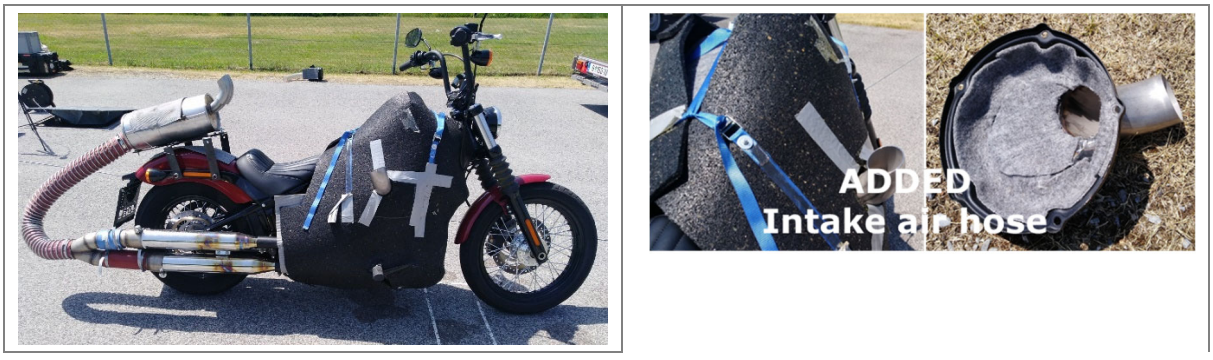

Figure 10: Engine & Exhaust damped version HD Street Bob

Encapsulation variant: Exhaust damped

Figure 11: Exhaust damped version HD Street Bob

Encapsulation variant: Original Setting

Figure 12: Original version HD Street Bob

4.3. Honda Forza 125

Figure 13: Honda Forza 125

Measurement procedure:

The vehicle was measured with CVT according to [1]

Table 8: Technical specifications Honda Forza 125

Specs		
Engine	single-cylinder liquid-cooled	124,9 cm³
Performance	10.7 kW @ 8,750 rpm	12.3 Nm @ 6,500 rpm
PMR	45.1	162 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 9: Mass data of encapsulation variants Honda Forza 125

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 24,45
Exhaust damping & Engine encapsulation	+ 21,55
Exhaust damping	+ 12,65
Racelogic GPS equipment + Backpack	+ 3,5

Table 10: Part list with masses of additional material (damping, encapsulation, equipment)
Honda Forza 125

Parts	Mass [kg]	Comment / Material
Total	24,45	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	9,15	
Exhaust muffler / oval small	6,7	2 extra mounting parts
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	0,35	
Engine damping	8,9	
Engine covers	8,9	belts/soft/heavy
Intake damping	2,9	
Intake damping	2,9	cage/foam/shell

Encapsulation variant: Fully encapsulated

Figure 14: Fully encapsulated version Honda Forza 125

Encapsulation variant: Engine & Exhaust damped

Figure 15: Engine & Exhaust damped version Honda Forza 125

Encapsulation variant: Exhaust damped

Figure 16: Exhaust damped version Honda Forza 125

Encapsulation variant: Original Setting

Figure 17: Original version Honda Forza 125

4.4. Kawasaki Vulcan S

Measurement procedure:

The vehicle was measured in 4th gear according to the manufacture's definition.

Table 11: Technical specifications Kawasaki Vulcan S

Specs		
Engine	2-cylinder liquid-cooled	649 cm³
Performance	44.7 @ 7,500 rpm	62,4 Nm @ 6,600 rpm
PMR	147	229 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 12: Mass data of encapsulation variants Kawasaki Vulcan S

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 25,76
Exhaust damping & Engine encapsulation	+ 25,76
Exhaust damping	+ 14,26
Racelogic GPS equipment + Backpack	+ 3,5

Table 13: Part list with masses of additional material (damping, encapsulation, equipment) Kawasaki Vulcan S

Part	Mass [kg]	Comment / Materials
Total	25,76	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	10,76	
Exhaust muffler / square	8,2	2 extra mounting parts
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	0,46	
Engine damping	11,5	
Engine covers	11,5	belts/soft/heavy
Intake damping	0	Covered orifices in engine cover
Intake damping	0	

Encapsulation variant: Fully encapsulated

Figure 18: Fully damped & encapsulated version Kawasaki Vulcan S

Encapsulation variant: Engine & Exhaust damped

Figure 19: Exhaust and engine damped / encapsulated version Kawasaki Vulcan S

Encapsulation variant: Exhaust damped

Figure 20: Exhaust damped / encapsulated version Kawasaki Vulcan

Encapsulation variant: Original Setting

Figure 21: Original version Kawasaki Vulcan S

4.5. KTM 390 Duke

Figure 22: KTM Duke 390

Measurement procedure:

The vehicle was measured in gear 3 according to the manufacture's definition.

Table 14: Technical specifications KTM Duke 390 MY 2021

Specs	
Engine	single-cylinder liquid-cooled, 373 cm^3
Performance	32kW
PMR	135

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 15: Mass data of encapsulation variants

Encapsulation Variant:	**Mass [kg]**
Variant 3: Fully Encapsuled / Damped	+ 22,16
Variant 2: Exhaust damping & Engine encapsulation	+ 19,76
Variant 1: Exhaust damping	+ 12,76
Base Variant 0: Racelogic GPS equipment + backpack	+ 3,5

Table 16: Part list with masses of additional material (damping, encapsulation, equipment)
KTM Duke 390

Parts	Mass [kg]	Comment / Material
Total	22,16	
Racelogic GPS equipment – Backpack	3,5	
Exhaust damping	9,26	
Exhaust muffler / oval small	6,7	2 extra mounting parts
HT hose/tube incl. 2 brackets	2,1	
Exhaust-hose connector	0,46	
Engine damping	7	
Engine covers	7	belts/soft/heavy
Intake damping	2,4	
Intake damping	2,4	vol./hose/connect.

Encapsulation variant: Fully encapsulated

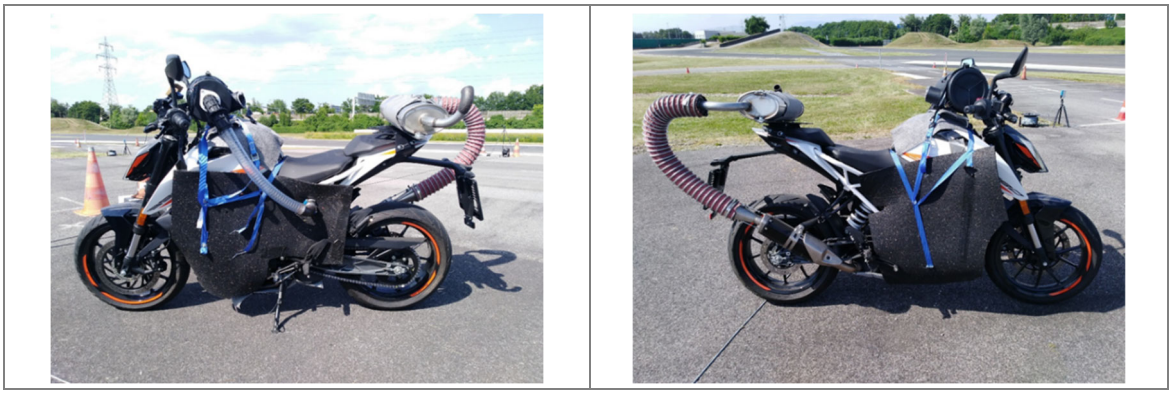

Figure 23: Fully encapsulated version KTM Duke 390

Encapsulation variant: Engine & Exhaust damped

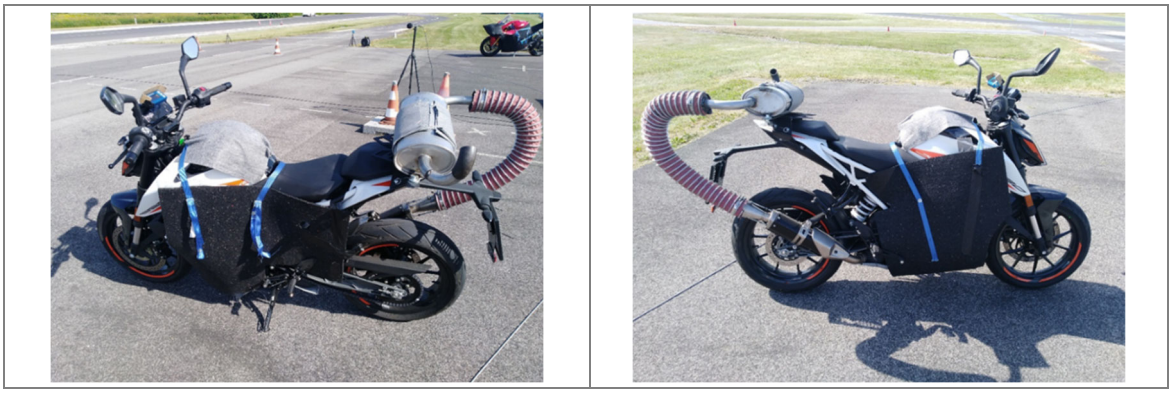

Figure 24: Engine & Exhaust damped version KTM Duke 390

Encapsulation variant: Exhaust damped

Figure 25: Exhaust damped version KTM Duke 390

Encapsulation variant: Original Setting

Figure 26: Original version KTM Duke 390

4.6. Piaggio Vespa 300 GT

Figure 27: Piaggio Vespa 300 GT

Measurement procedure:

The vehicle was measured with CVT according to [1]

Table 17: Technical specifications Piaggio Vespa 300 GT

Specs		
Engine	single-cylinder liquid-cooled	278 cm^3
Performance	15.5 @ 8,250 rpm	26 Nm @ 5,250 rpm
PMR	60.1	183 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 18: Mass data of encapsulation variants

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 23,25
Exhaust damping & Engine encapsulation	+ 21,85
Exhaust damping	+ 12,85
Racelogic GPS equipment + Backpack	+ 3,5

Table 19: Part list with masses of additional material (damping, encapsulation, equipment)

Parts	Mass [kg]	Comment / Material
Total	23,25	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	9,35	
Exhaust muffler / oval small	6,9	2 extra mounting parts
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	0,35	
Engine damping	9	
Engine covers	9	belts/soft/heavy
Intake damping	1,4	
Intake damping	1,4	soft/heavy

Encapsulation variant: Fully encapsulated

Figure 28: Fully encapsulated version Piaggio Vespa 300 GT

Encapsulation variant: Engine & Exhaust damped

Figure 29: Engine & Exhaust damped version Piaggio Vespa 300 GT

Encapsulation variant: Exhaust damped

Figure 30: Exhaust damped version Piaggio Vespa 300 GT

Encapsulation variant: Original Setting

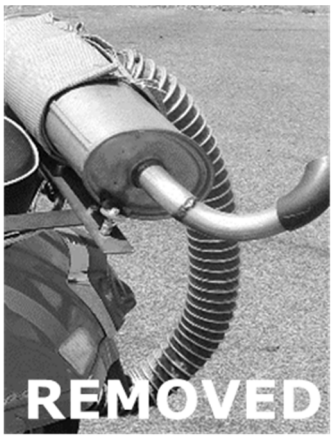

Figure 31: Original version Piaggio Vespa 300 GT

4.7. Triumph Street Triple R

Figure 32: Triumph Street Triple R

Measurement procedure:

The vehicle was measured in 3rd gear according to the manufacture's definition.

Table 20: Technical specifications Triumph Street Triple R

Specs		
Engine	In-line 3-cylinder, liquid-cooled	765 cm^3
Performance	86.8 @ 11,750 rpm	79 Nm @ 9,350 rpm
PMR	331	187 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 21: Mass data of encapsulation variants Triumph Street Triple R

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 29,86
Exhaust damping & Engine encapsulation	+ 26,26
Exhaust damping	+ 14,96
Racelogic GPS equipment + Backpack	+ 3,5

Table 22: Part list with masses of additional material (damping, encapsulation, equipment)

Parts	Mass [kg]	Comment / Material
Total	29,86	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	11,46	
Exhaust muffler / square	8,9	incl. rack + mounting parts
HT hose/tube incl. 2 brackets	2,1	HT 500
Exhaust-hose connector	0,46	
Engine damping	11,3	
Engine covers	11,3	belts/soft/heavy
Intake damping	3,6	
Intake damping	3,6	cage/soft/heavy

Encapsulation variant: Fully encapsulated

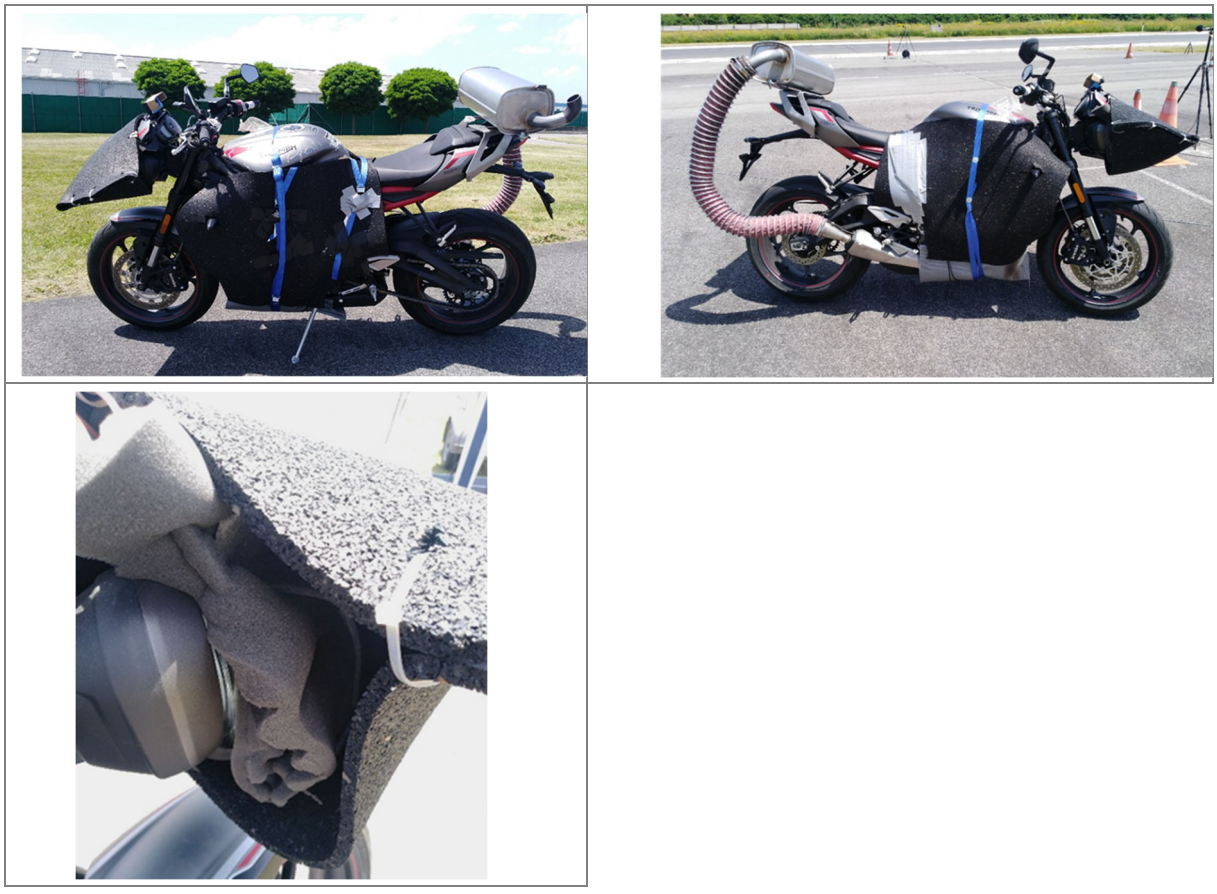

Figure 33: Fully encapsulated version Triumph Street Triple R

Encapsulation variant: Engine & Exhaust damped

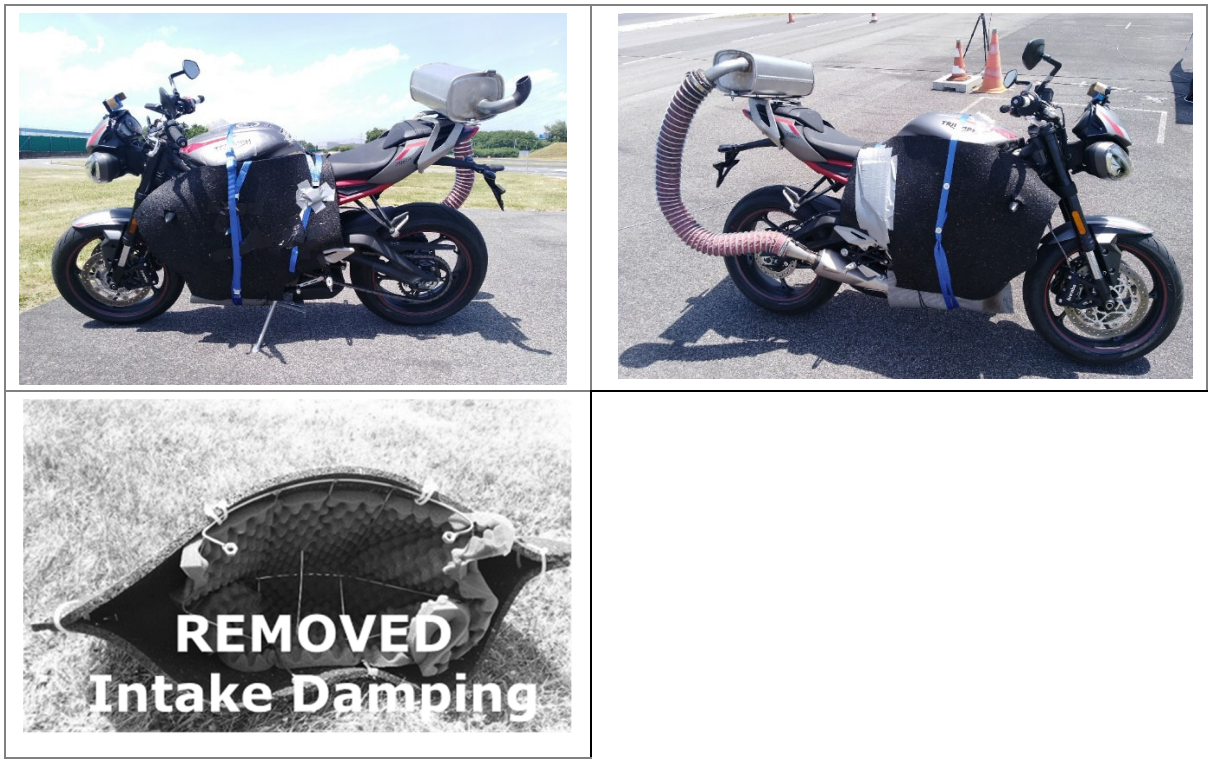

Figure 34: Engine & Exhaust damped version Triumph Street Triple R

Encapsulation variant: Exhaust damped

Figure 35: Exhaust damped version Triumph Street Triple R

Encapsulation variant: Original Setting

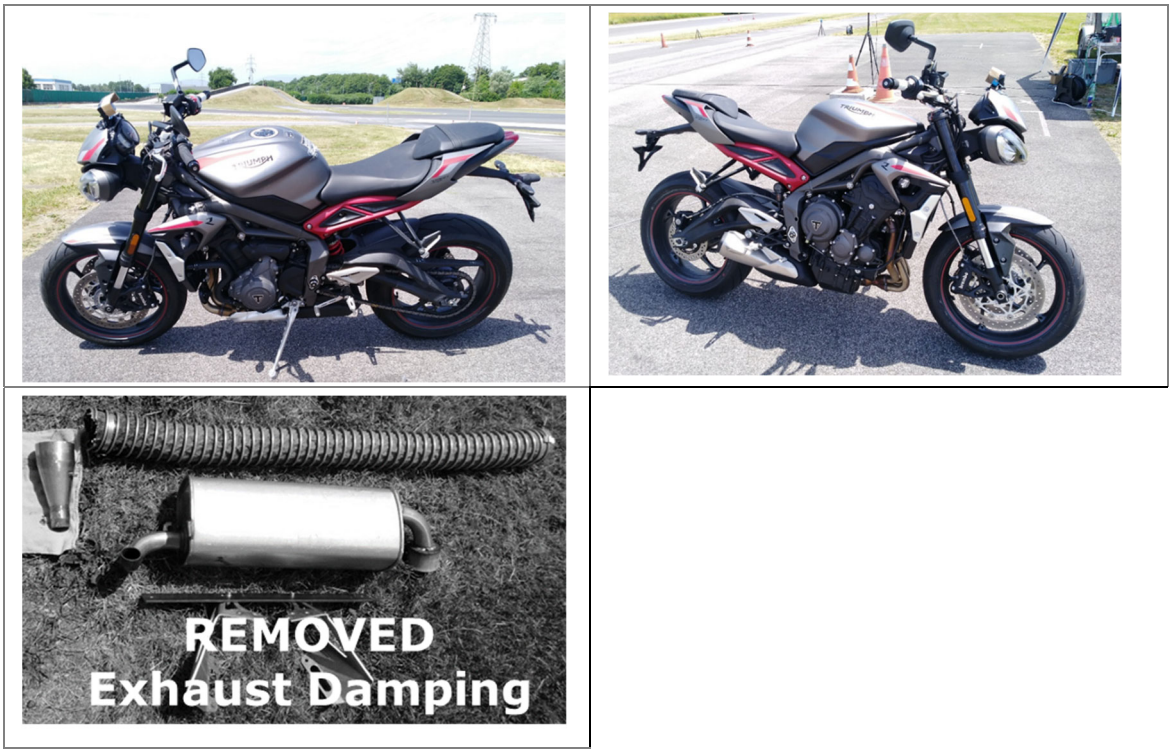

Figure 36: Original version Triumph Street Triple R

4.8. Yamaha T-Max

Measurement procedure:

The vehicle was measured with CVT according to [1]

Table 23: Technical specifications Yamaha T-Max

Specs		
Engine	2 cyl. In-line, liquid cooled	562 cm³
Performance	35.0 kW @ 7,500 U/min	55.7 Nm @ 5,250 U/min
PMR	119.5	218 kg

Damping / Encapsulation

The vehicle was equipped with damping / encapsulation material in 3 steps as described below, allowing a distinction between the 4 different noise influences (see 3.3).

Table 24: Mass data of encapsulation variants Yamaha T-Max

Encapsulation Variant:	Mass [kg]
Fully Encapsuled / Damped	+ 22,68
Exhaust damping & Engine encapsulation	+ 22,58
Exhaust damping	+ 13,68
Racelogic GPS equipment + Backpack	+ 3,5

Table 25: Part list with masses of additional material (damping, encapsulation, equipment) Yamaha T-Max

Parts	Mass [kg]	Comment / Material
Total	22,68	
Racelogic GPS equipment - Backpack	3,5	
Exhaust damping	10,18	
Exhaust muffler / square	7,7	incl. mounting parts
HT hose/tube incl. 2 brakets	2,1	
Exhaust-hose connector	0,38	
Engine damping	8,9	
Engine covers	8,9	fix/soft/heavy
Intake damping	0,1	
Intake damping	0,1	felt layer

Encapsulation variant: Fully encapsulated

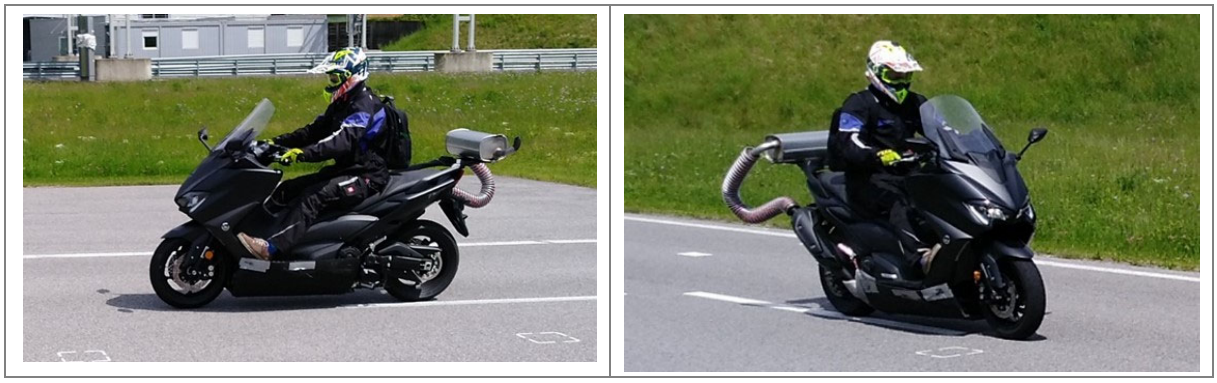

Figure 37: Fully damped & encapsulated version Yamaha T-Max

Encapsulation variant: Engine & Exhaust damped

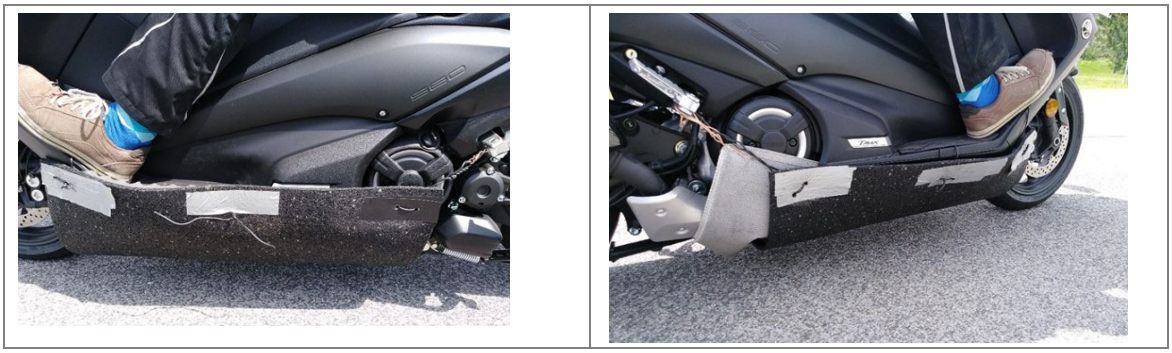

Figure 38: Exhaust and engine damped / encapsulated version Yamaha T-Max

Encapsulation variant: Exhaust damped

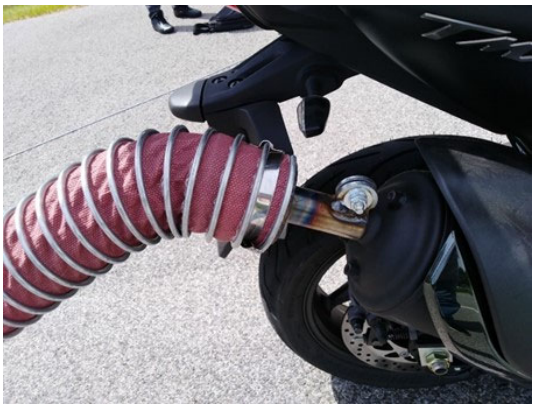

Figure 39: Exhaust damped / encapsulated version Yamaha T-Max

Encapsulation variant: Original Setting

Figure 40: Original version Yamaha T-Max

5. Pass-by Measurements according to UNECE-R 41.04. / Annex 3

5.1. BMW R 1250 GS

BMW R 1250 GS Overall Results UNECE-R 41.04. / Annex 3

Table 26: Measurement result BMW 1250 GS UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

BMW R 1250 GS ANNEX 3								
Lurban	**Lwot,rep**	**Lcrs,rep**	**a urban [m/s²]**	**a wot,ref [m/s²]**	**kp**	**k**	**Calc. Type**	**PMR**
74,2	78,5	69,7	2,00	4,13	0,49	0	R41 rev3	308.6

Table 27: Measurement result BMW 1250 GS UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

BMW R 1250 GS ANNEX 3				
	L [dB(A)]	**Lmax L [dB(A)]**	**Lmax R [dB(A)]**	**a [m/s²]**
Acceleration WOT	78,5	77,6	78,5	3,88
Constant 50 km/h	69,7	69,7	69,4	0,11

BMW 1250 GS Reference Measurements Vehicle Speed & Acceleration

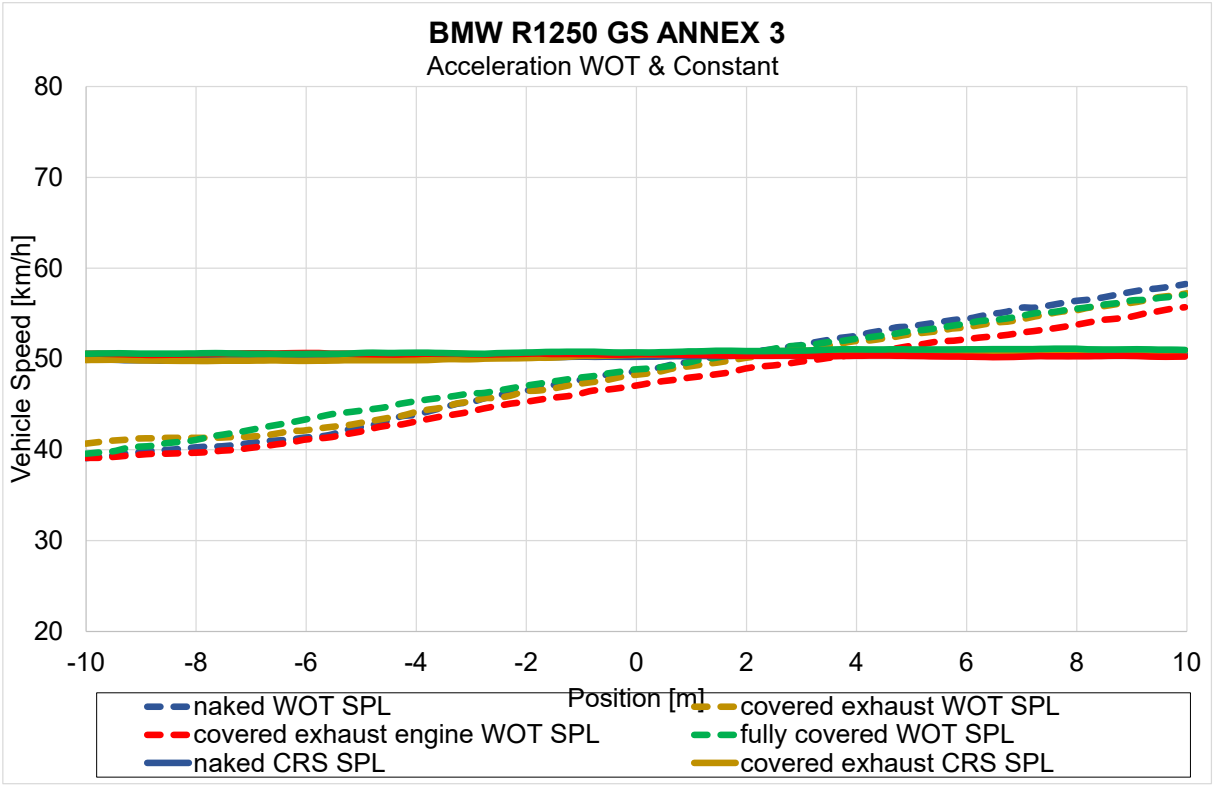

Figure 41: BMW 1250 GS Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

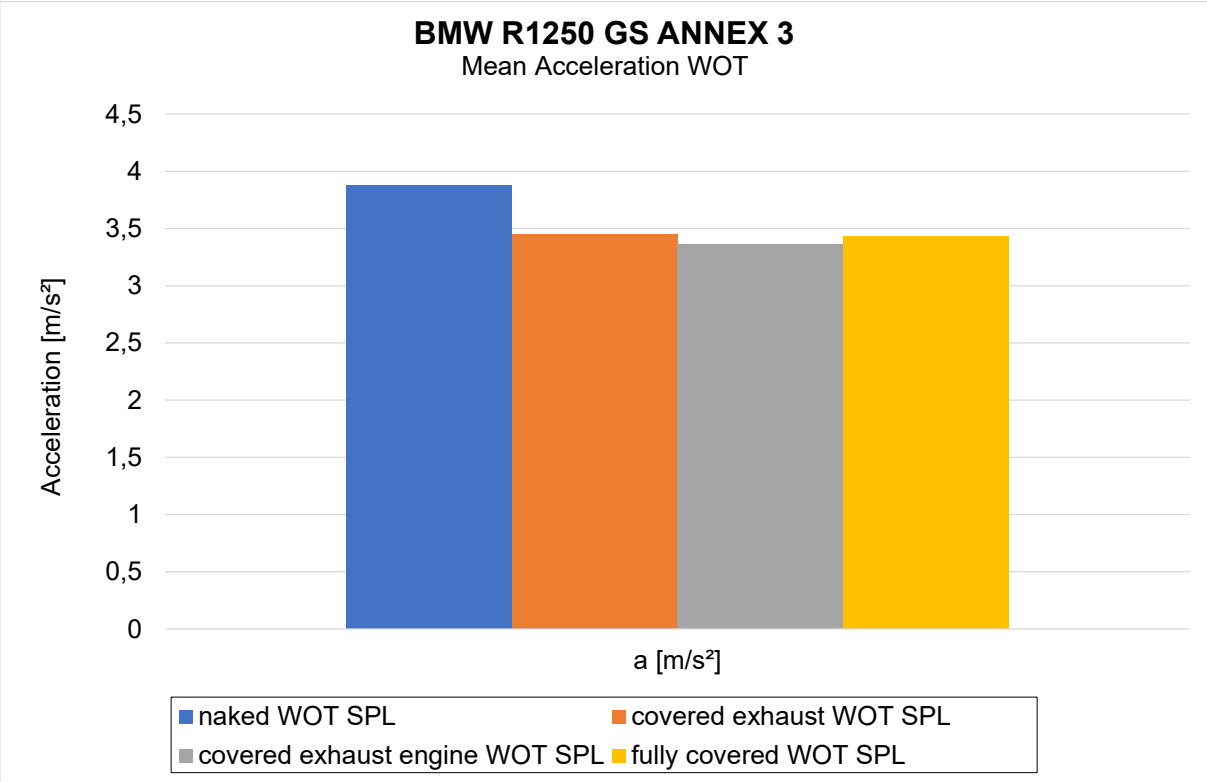

Figure 42: BMW 1250 GS WOT / Comparison noise damping variants

BMW 1250 GS Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

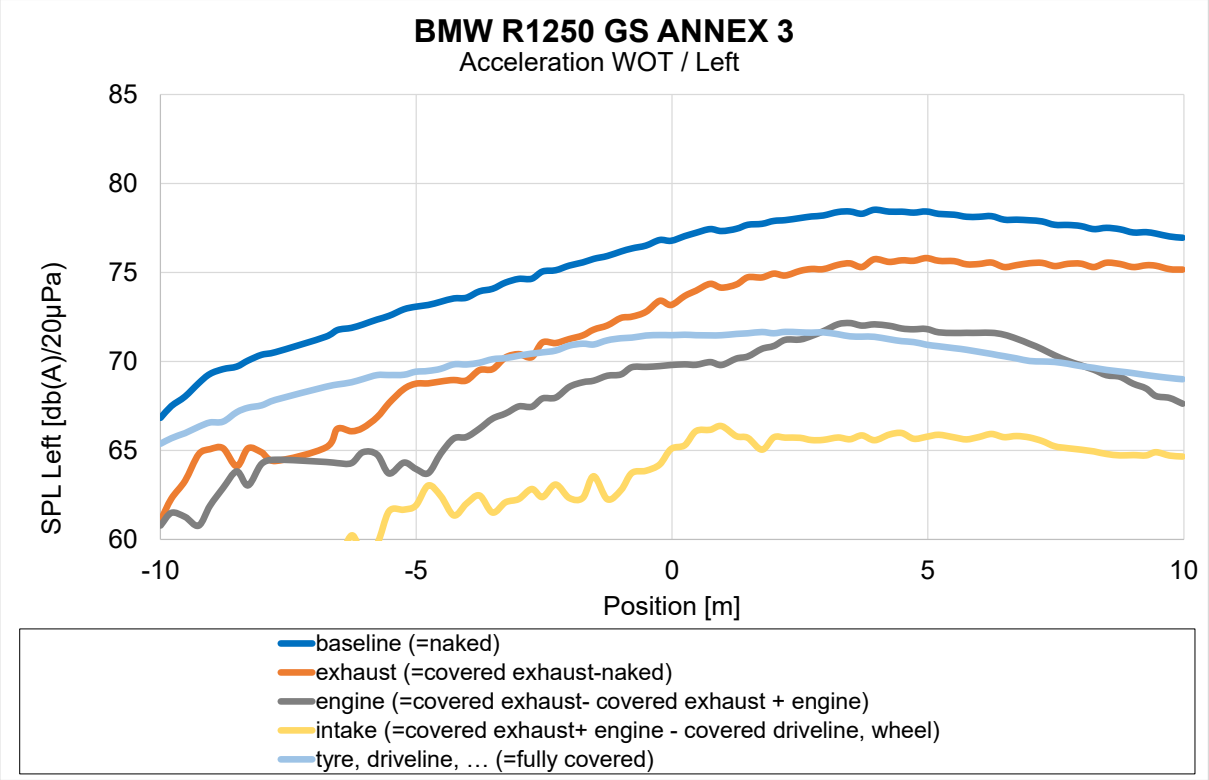

Figure 43: BMW 1250 GS Noise Contribution of Components 4th Gear Acceleration WOT left vehicle side

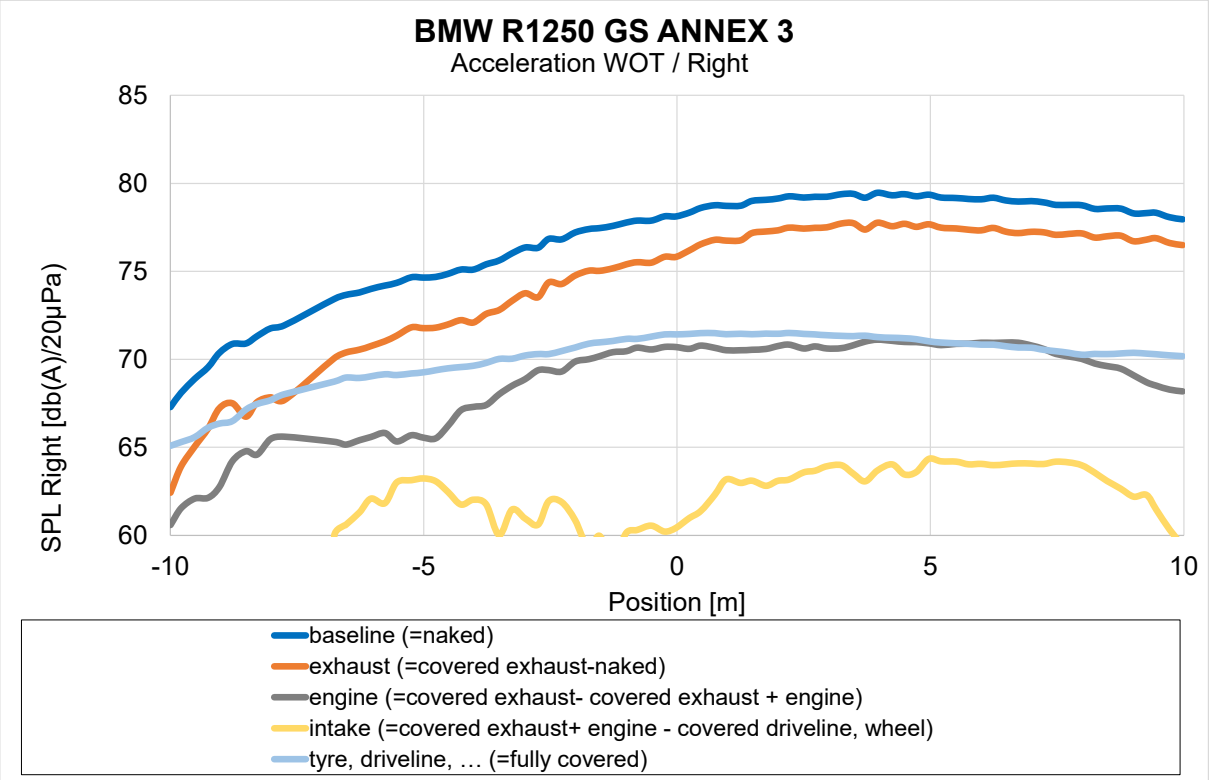

Figure 44: BMW 1250 GS Noise Contribution of Components 4th Gear Acceleration WOT right vehicle side

Table 28: BMW 1250 GS UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Acceleration WOT left vehicle side

BMW R1250 GS ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	78,5
exhaust (=covered exhaust-naked)	75,8
engine (=covered exhaust- covered exhaust + engine)	72,2
intake (=covered exhaust+ engine - covered driveline, wheel)	66,4
tyre, driveline, … (=fully covered)	71,7

Table 29: BMW 1250 GS UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Acceleration WOT right vehicle side

BMW R1250 GS ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	79,5
exhaust (=covered exhaust-naked)	77,8
engine (=covered exhaust- covered exhaust + engine)	71,1
intake (=covered exhaust+ engine - covered driveline, wheel)	64,4
tyre, driveline, … (=fully covered)	71,5

BMW 1250 GS Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

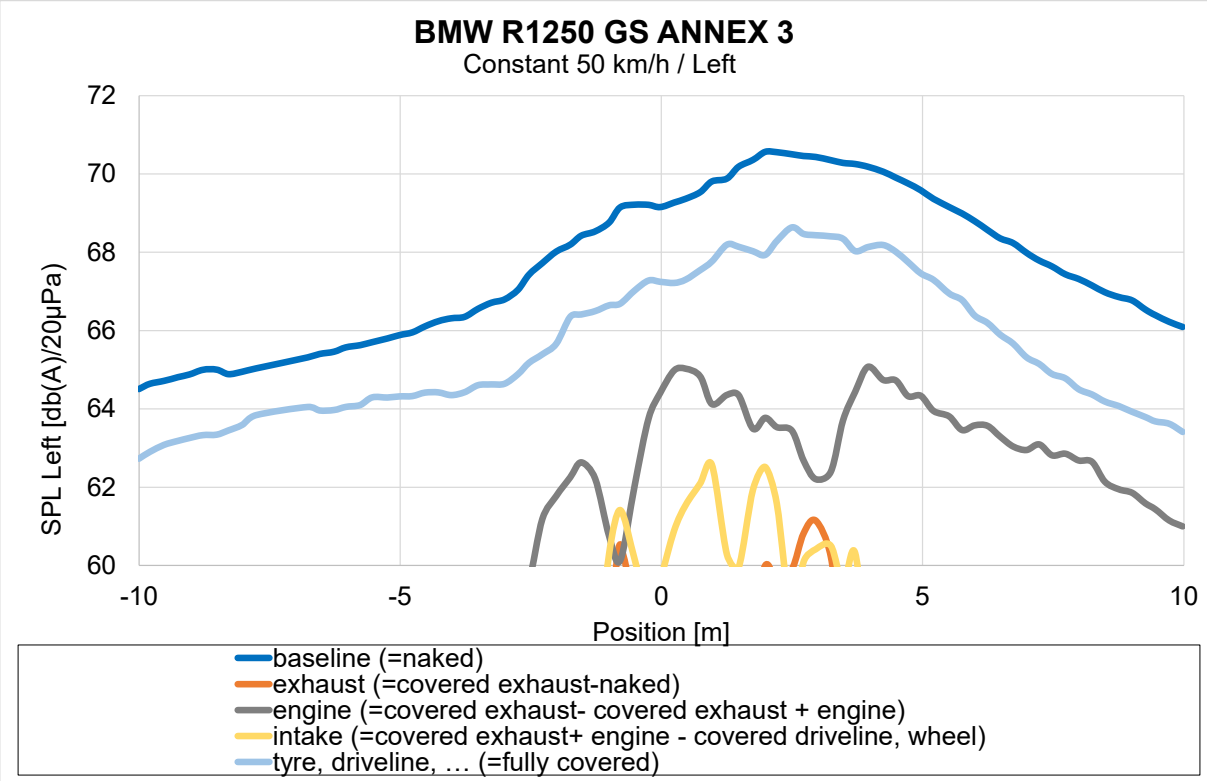

Figure 45: BMW 1250 GS Noise Contribution of Components 4th Gear Constant Speed 50 km/h left vehicle side

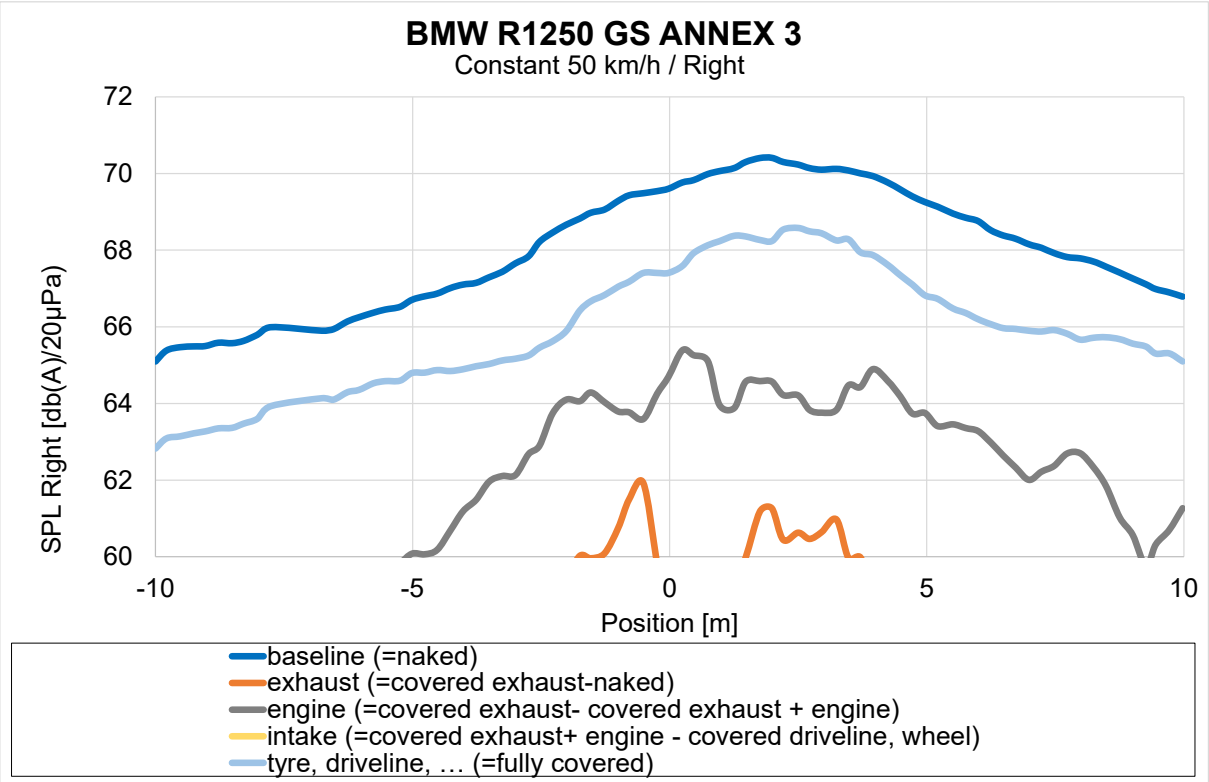

Figure 46: BMW 1250 GS Noise Contribution of Components 4th Gear Constant Speed 50 km/h right vehicle side

Table 30: BMW 1250 GS UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Constant Speed 50km/h left vehicle side

BMW R1250 GS ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	70,6
exhaust (=covered exhaust-naked)	61,1
engine (=covered exhaust- covered exhaust + engine)	65,1
intake (=covered exhaust+ engine - covered driveline, wheel)	62,6
tyre, driveline, … (=fully covered)	68,6

Table 31: BMW 1250 GS UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Constant Speed 50km/h right vehicle side

BMW R1250 GS ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	70,4
exhaust (=covered exhaust-naked)	61,9
engine (=covered exhaust- covered exhaust + engine)	65,4
intake (=covered exhaust+ engine - covered driveline, wheel)	57,0
tyre, driveline, … (=fully covered)	68,6

5.2. Harley Davidson Street Bob

HD Street Bob Overall Results UNECE-R 41.04. / Annex 3

Table 32: Measurement result HD Street Bob UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

HD Street Bob ANNEX 3								
Lurban	**Lwot,rep**	**Lcrs,rep**	**a urban [m/s²]**	**a wot,ref [m/s²]**	**kp**	**k**	**Calc. Type**	**PMR**
74,8	79,3	70,2	1,67	3,28	0,49	0,40	R41 rev3	172

Table 33: Measurement result HD Street Bob UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

HD Street Bob ANNEX 3				
	L [dB(A)]	**Lmax L [dB(A)]**	**Lmax R [dB(A)]**	**a [m/s²]**
Acceleration WOT 3rd	81,0	79,4	81,0	3,85
Acceleration WOT 4th	78,1	77,5	78,1	2,90
Constant 50 km/h 3rd	71,1	71,1	69,7	-0,06
Constant 50 km/h 4th	69,6	69,6	68,8	0,02

HD Street Bob Reference Measurements Vehicle Speed & Acceleration

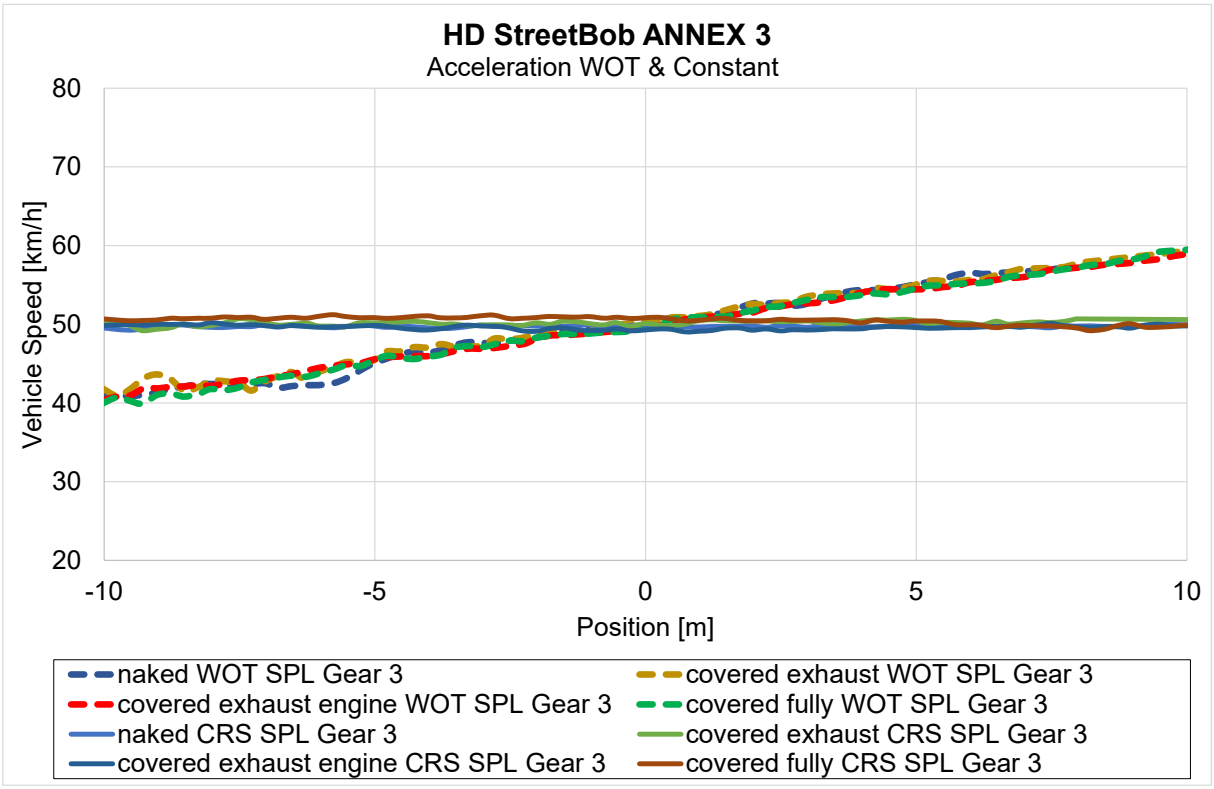

Figure 47: HD Street Bob Vehicle Speed for Acceleration WOT & Constant Speed 3rd Gear: Comparison noise damping variants

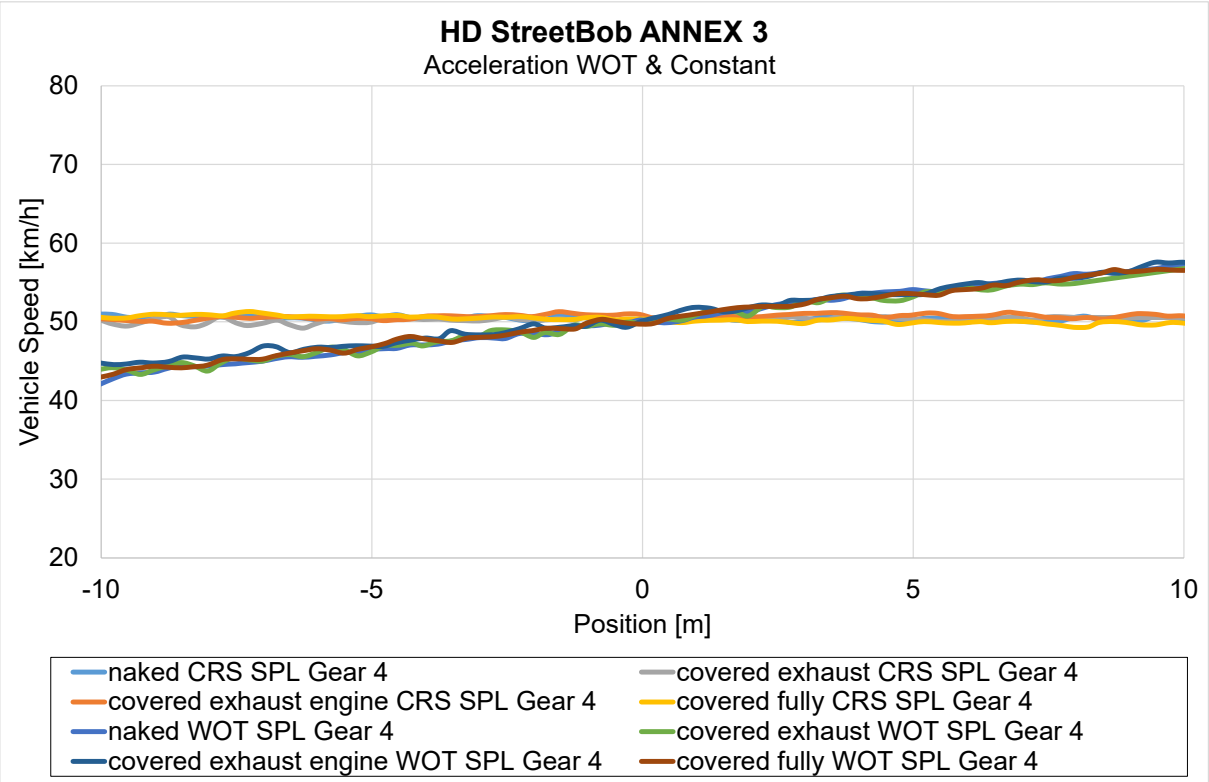

Figure 48: HD Street Bob Vehicle Speed for Acceleration WOT & Constant Speed 4th Gear Comparison noise damping variants

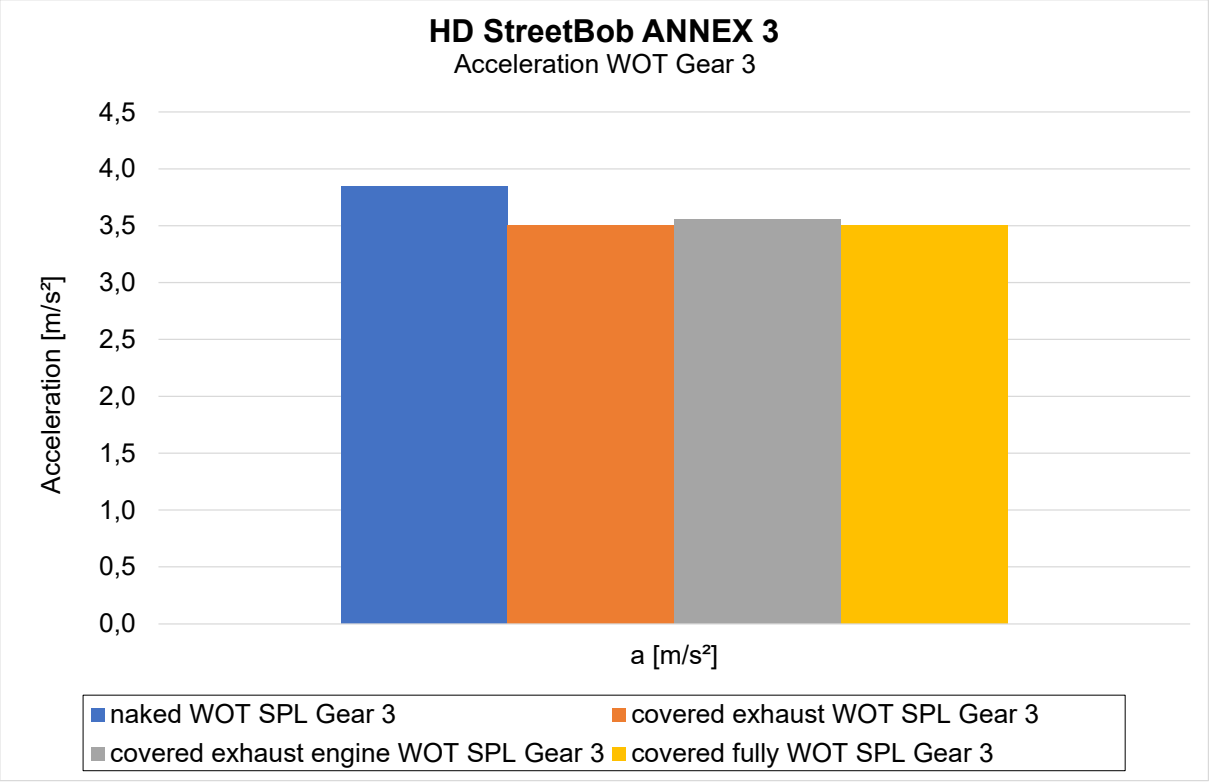

Figure 49: HD Street Bob Acceleration WOT 3rd Gear / Comparison noise damping variants

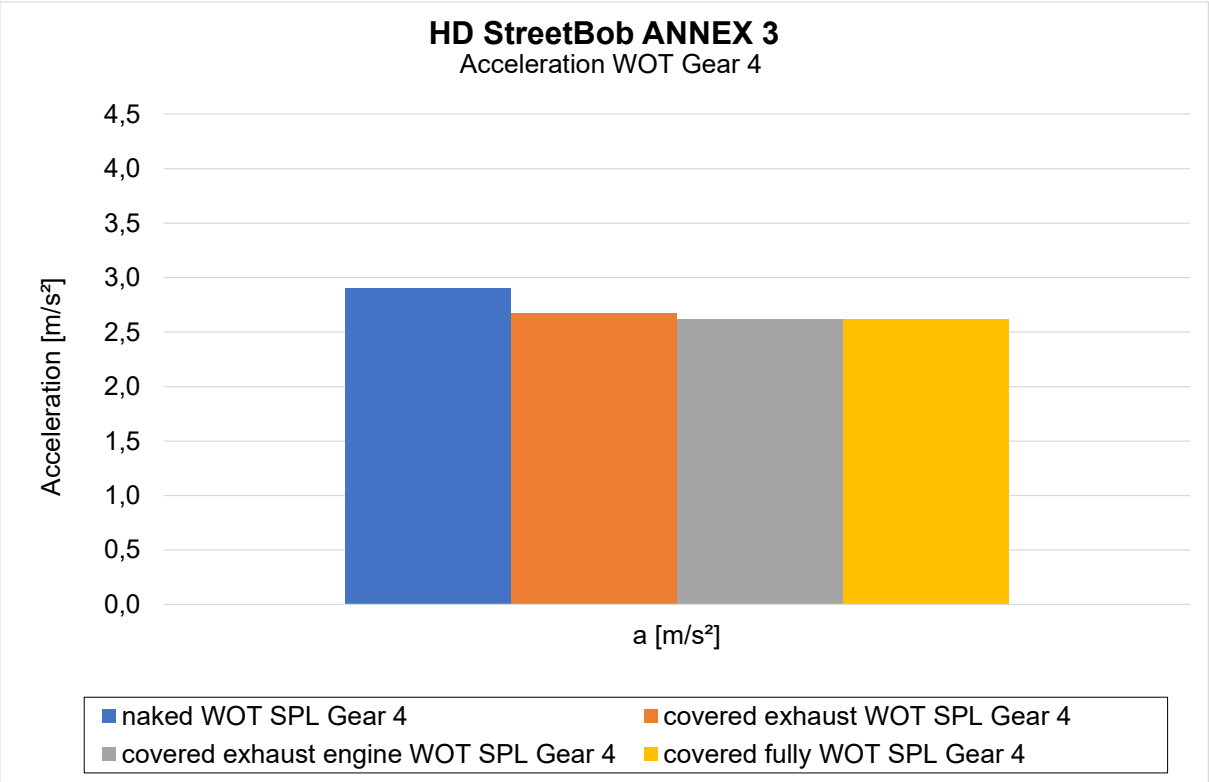

Figure 50: HD Street Bob Acceleration WOT 4th Gear / Comparison noise damping variants

HD Street Bob Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

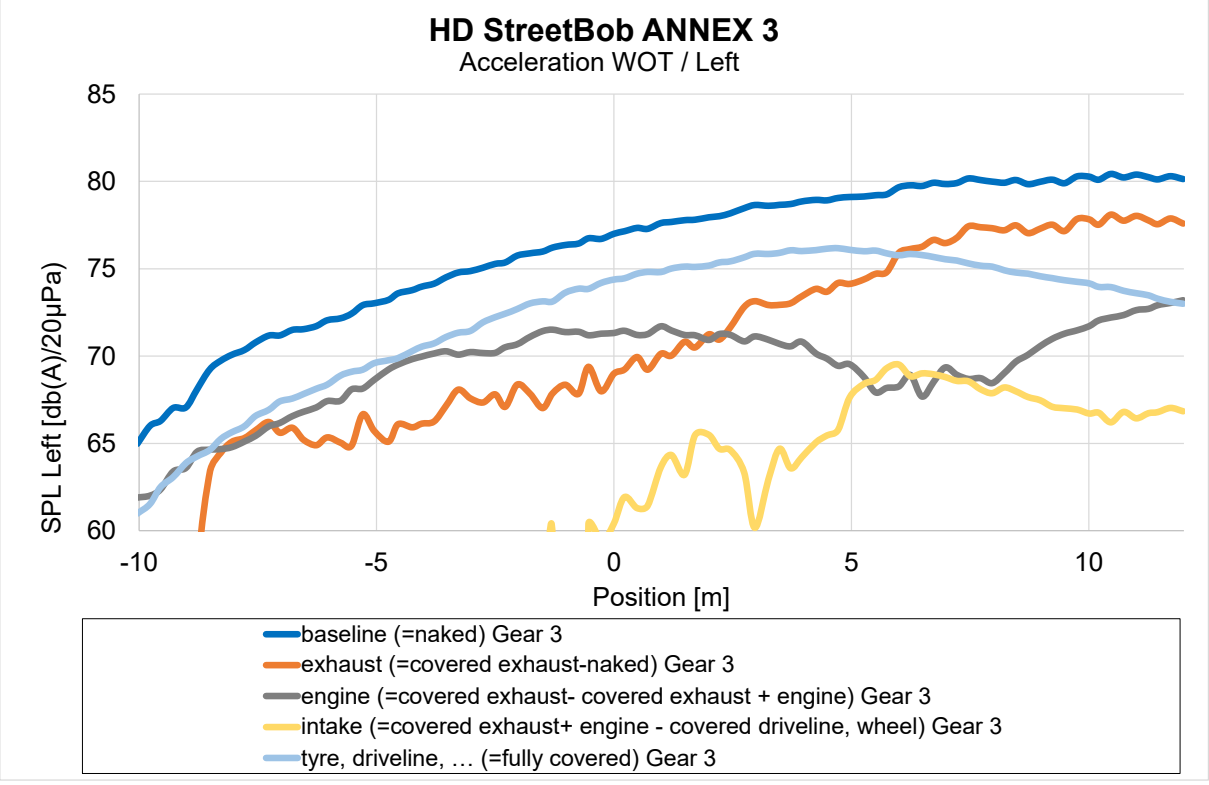

Figure 51: HD Street Bob Noise Contribution of Components 3rd Gear Acceleration WOT left vehicle side

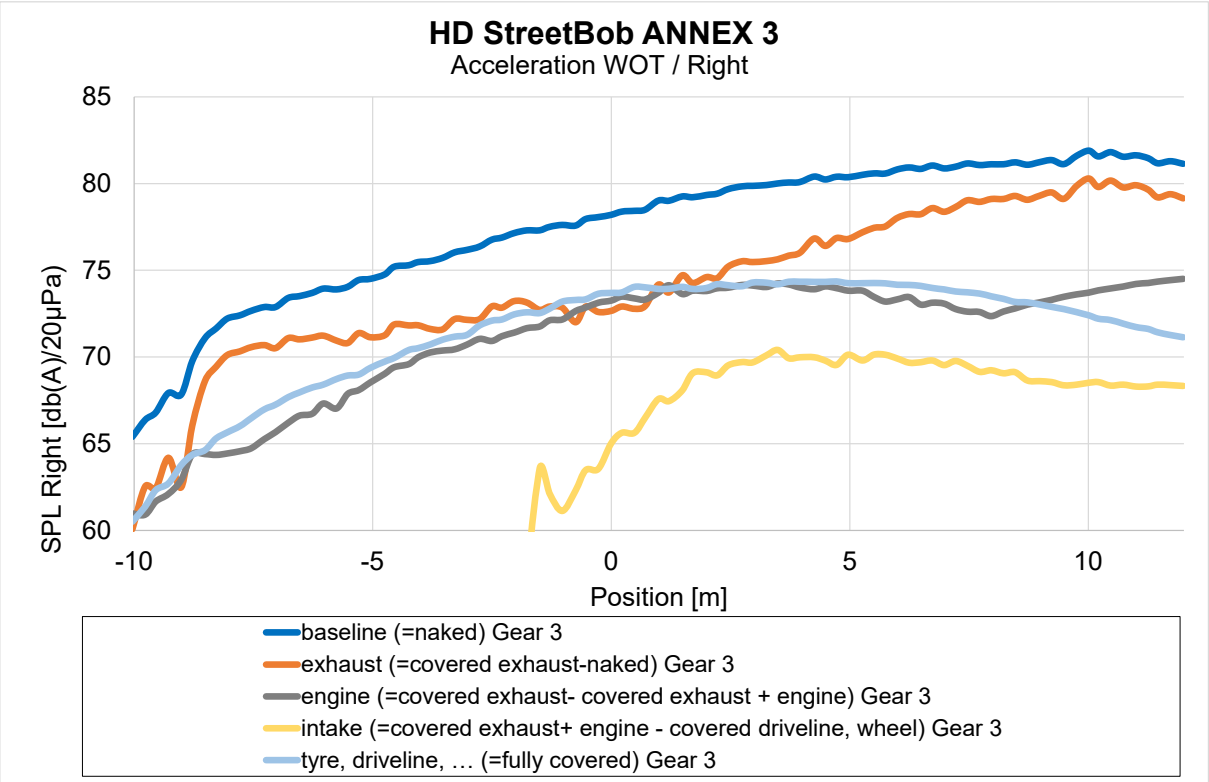

Figure 52: HD Street Bob Noise Contribution of Components 3rd Gear Acceleration WOT right vehicle side

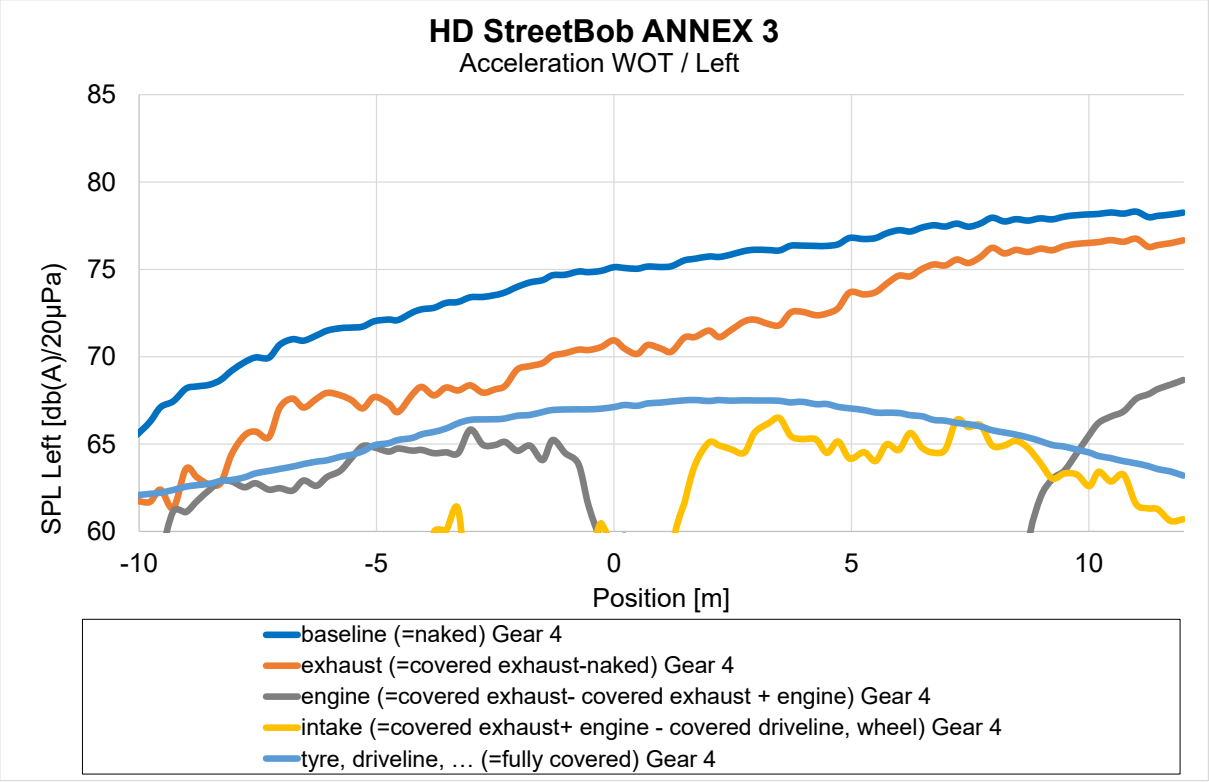

Figure 53: HD Street Bob Noise Contribution of Components 4th Gear Acceleration WOT left vehicle side

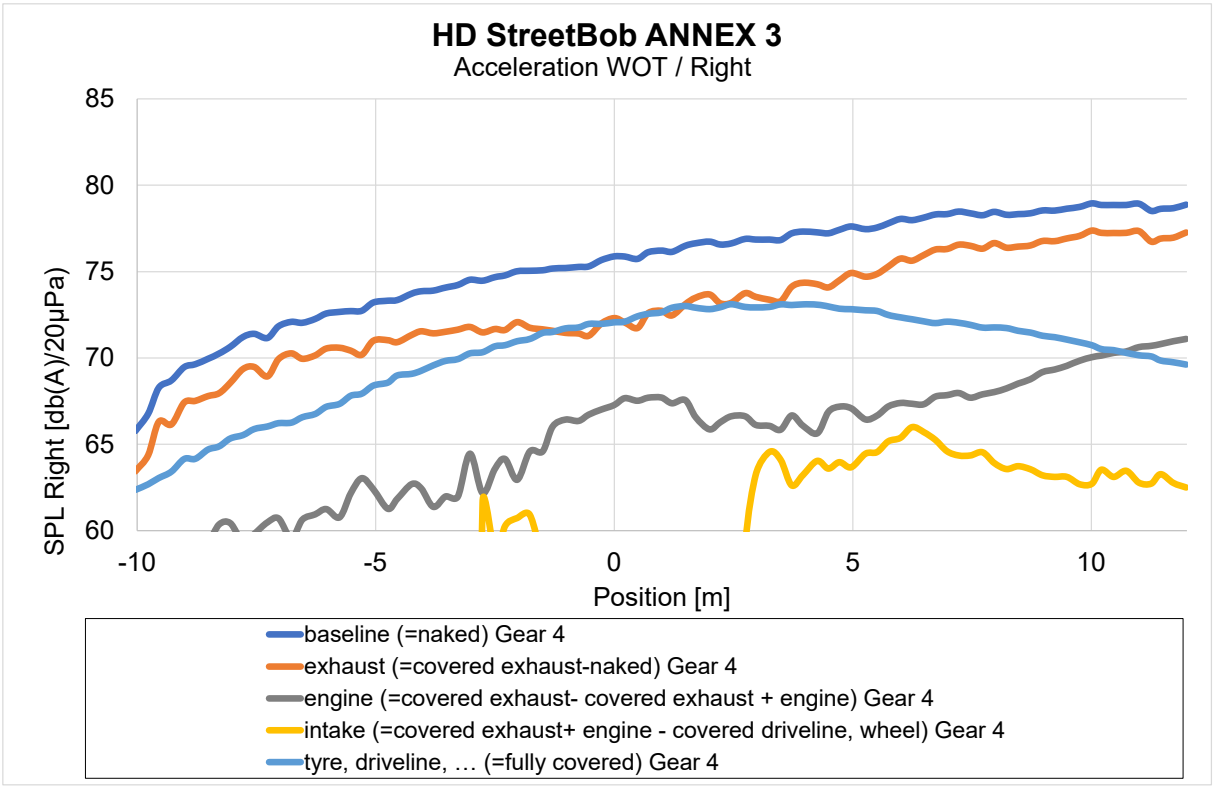

Figure 54: HD Street Bob Noise Contribution of Components 4th Gear Acceleration WOT right vehicle side

Table 34: HD Street Bob: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd & 4th Gear Acceleration WOT left vehicle side

HD Streetbob ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked) Gear 3	79,2
exhaust (=covered exhaust-naked) Gear 3	76,4
engine (=covered exhaust- covered exhaust + engine) Gear 3	70,7
intake (=covered exhaust+ engine - covered driveline, wheel) (	68,5
tyre, driveline, ... (=fully covered) Gear 3	75,2
baseline (=naked) Gear 4	77,0
exhaust (=covered exhaust-naked) Gear 4	75,2
engine (=covered exhaust- covered exhaust + engine) Gear 4	64,8
intake (=covered exhaust+ engine - covered driveline, wheel) (	65,5
tyre, driveline, ... (=fully covered) Gear 4	66,5

Table 35: HD Street Bob: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd & 4th Gear Acceleration WOT right vehicle side

HD Streetbob ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked) Gear 3	80,2
exhaust (=covered exhaust-naked) Gear 3	78,1
engine (=covered exhaust- covered exhaust + engine) Gear 3	73,2
intake (=covered exhaust+ engine - covered driveline, wheel) (	69,4
tyre, driveline, ... (=fully covered) Gear 3	73,4
baseline (=naked) Gear 4	77,5
exhaust (=covered exhaust-naked) Gear 4	75,7
engine (=covered exhaust- covered exhaust + engine) Gear 4	67,0
intake (=covered exhaust+ engine - covered driveline, wheel) (	65,0
tyre, driveline, ... (=fully covered) Gear 4	72,1

HD Street Bob Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

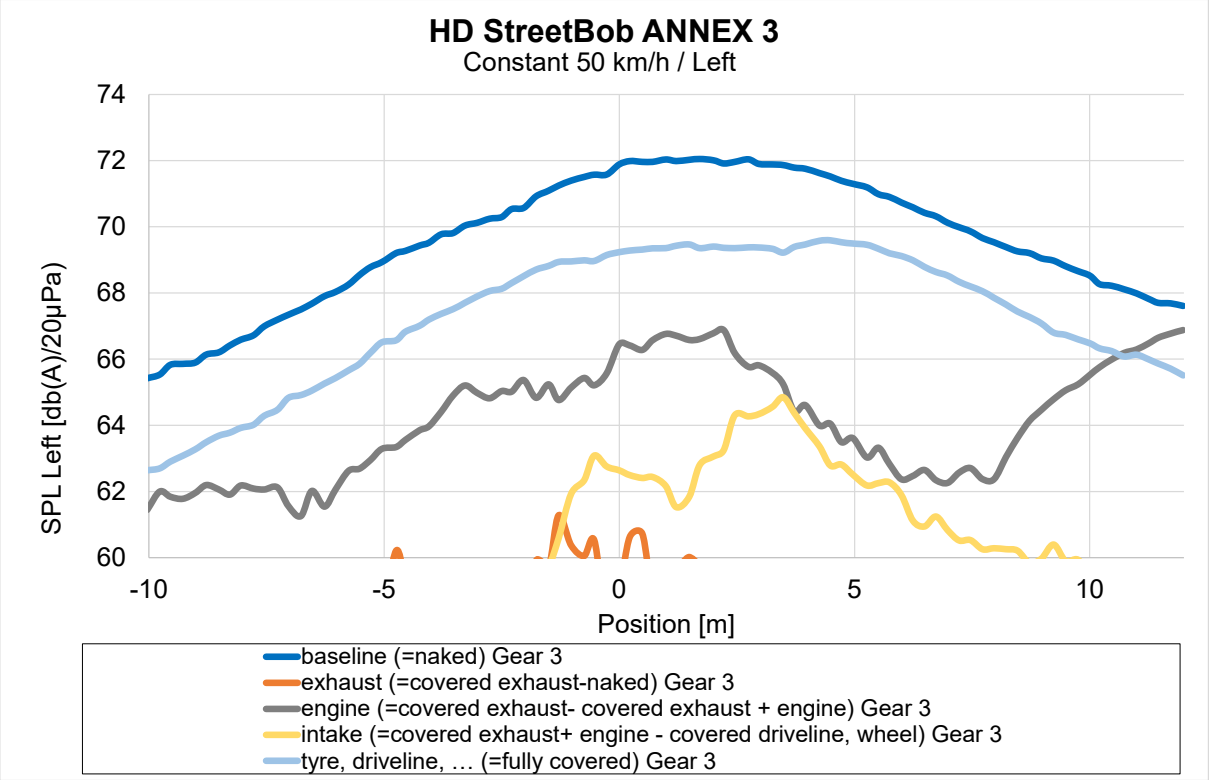

Figure 55: HD Street Bob Noise Contribution of Components 3rd Gear Constant Speed 50 km/h left vehicle side

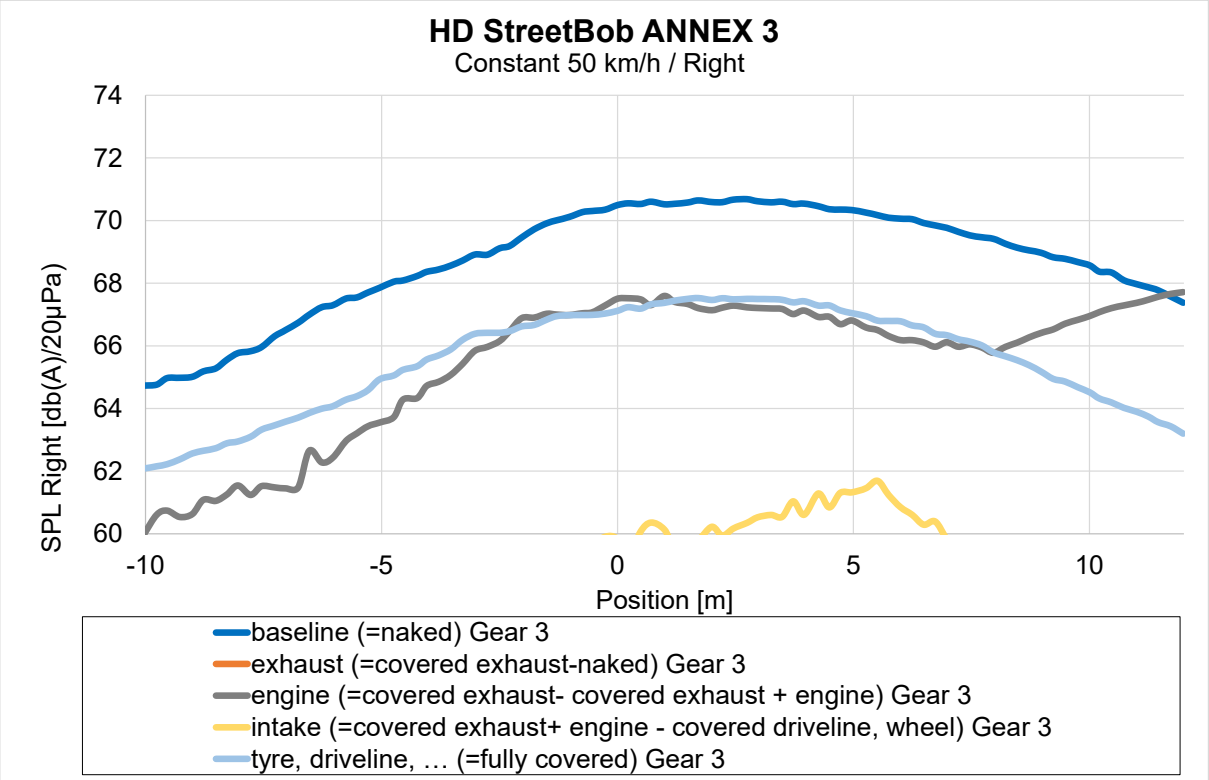

Figure 56: HD Street Bob Noise Contribution of Components 3rd Gear Constant Speed 50 km/h right vehicle side

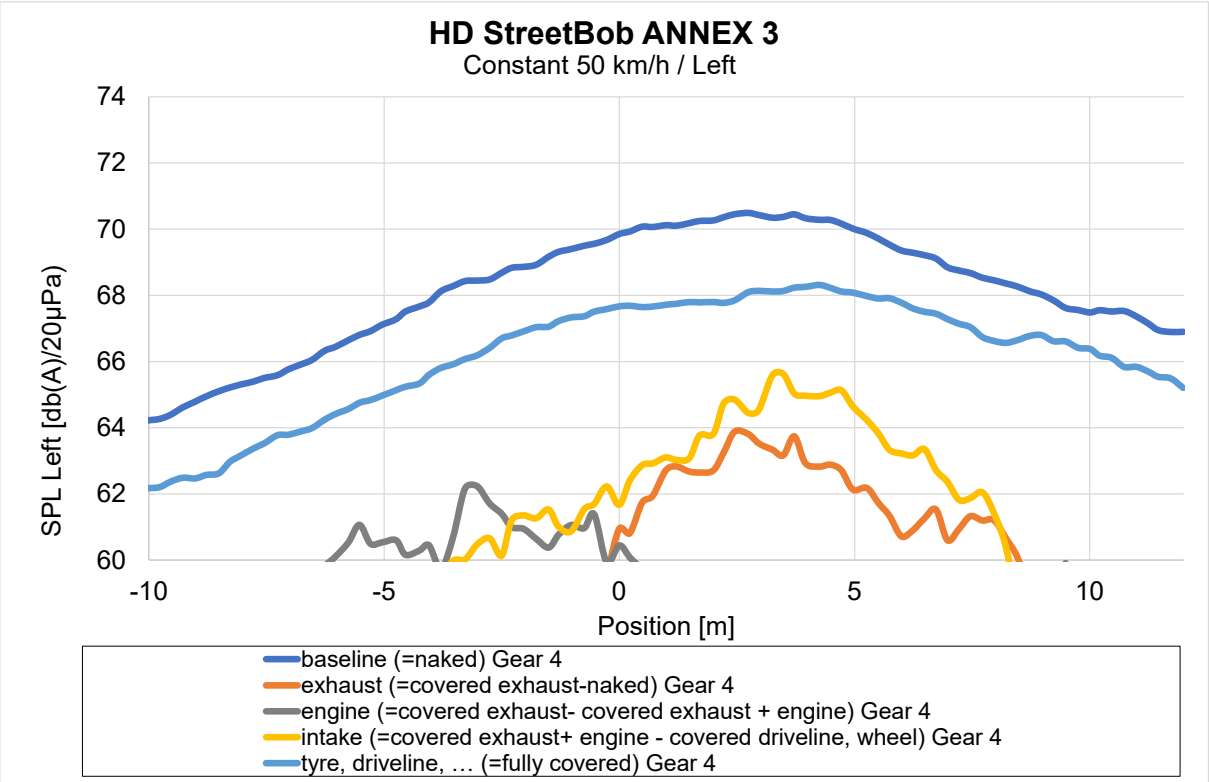

Figure 57: HD Street Bob Noise Contribution of Components 4th Gear Constant Speed 50 km/h left vehicle side

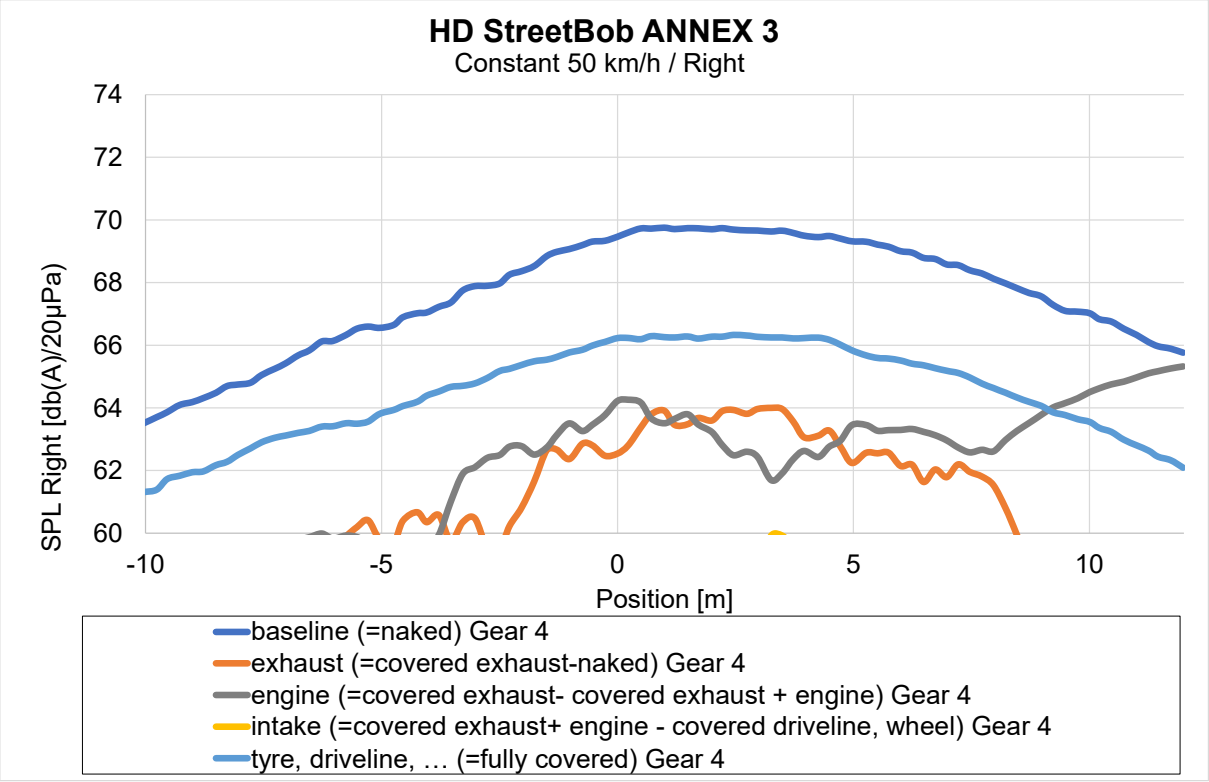

Figure 58: HD Street Bob Noise Contribution of Components 4th Gear Constant Speed 50 km/h right vehicle side

Table 36: HD Street Bob: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd & 4th Gear Constant Speed 50km/h left vehicle side

HD Streetbob ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked) Gear 3	71,0
exhaust (=covered exhaust-naked) Gear 3	60,3
engine (=covered exhaust- covered exhaust + engine) Gear 3	65,9
intake (=covered exhaust+ engine - covered driveline, wheel) (	63,8
tyre, driveline, ... (=fully covered) Gear 3	68,6
baseline (=naked) Gear 4	69,5
exhaust (=covered exhaust-naked) Gear 4	62,9
engine (=covered exhaust- covered exhaust + engine) Gear 4	61,2
intake (=covered exhaust+ engine - covered driveline, wheel) (	64,6
tyre, driveline, ... (=fully covered) Gear 4	67,3

Table 37: HD Street Bob: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd & 4th Gear Constant Speed 50km/h right vehicle side

HD Streetbob ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked) Gear 3	69,7
exhaust (=covered exhaust-naked) Gear 3	57,6
engine (=covered exhaust- covered exhaust + engine) Gear 3	66,6
intake (=covered exhaust+ engine - covered driveline, wheel) (	60,7
tyre, driveline, ... (=fully covered) Gear 3	66,5
baseline (=naked) Gear 4	68,8
exhaust (=covered exhaust-naked) Gear 4	63,0
engine (=covered exhaust- covered exhaust + engine) Gear 4	63,3
intake (=covered exhaust+ engine - covered driveline, wheel) (	58,9
tyre, driveline, ... (=fully covered) Gear 4	65,3

5.3. Honda Forza 125

Honda Forza 125 Overall Results UNECE-R 41.04. / Annex 3

Table 38: Measurement result HONDA FORZA 125 UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

Forza 125 ANNEX 3								
Lurban	**Lwot,rep**	**Lcrs,rep**	**a urban [m/s²]**	**a wot,ref [m/s²]**	**kp**	**k**	**Calc. Type**	**PMR**
74,5	77,8	68,7	1,19	1,57	0,36	0	R41 rev3	45.1

Table 39: Measurement result HONDA FORZA 125 UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

Forza 125 ANNEX 3				
	L [dB(A)]	**Lmax L [dB(A)]**	**Lmax R [dB(A)]**	**a [m/s²]**
Acceleration WOT	78,8	75,6	77,8	1,86
Constant 50 km/h	68,7	67,5	68,7	0,05

Honda Forza 125 Reference Measurements Vehicle Speed & Acceleration

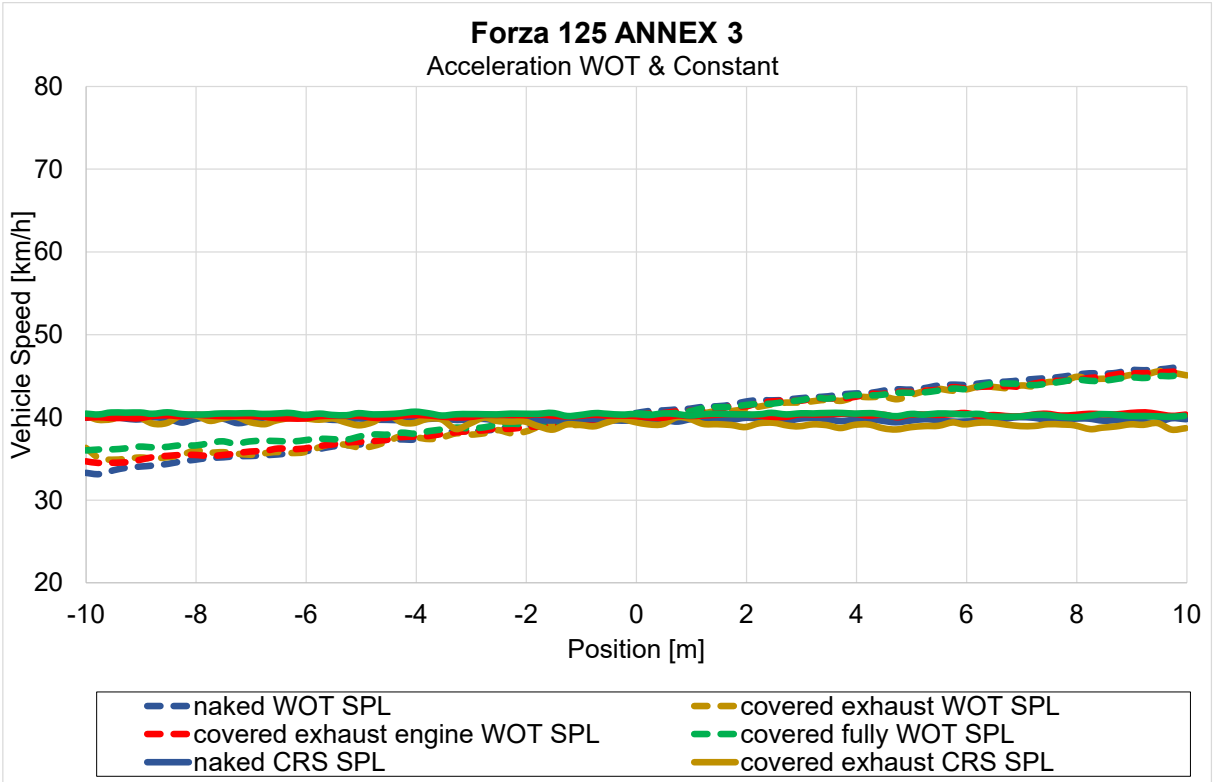

Figure 59: HONDA FORZA 125 ANNEX Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

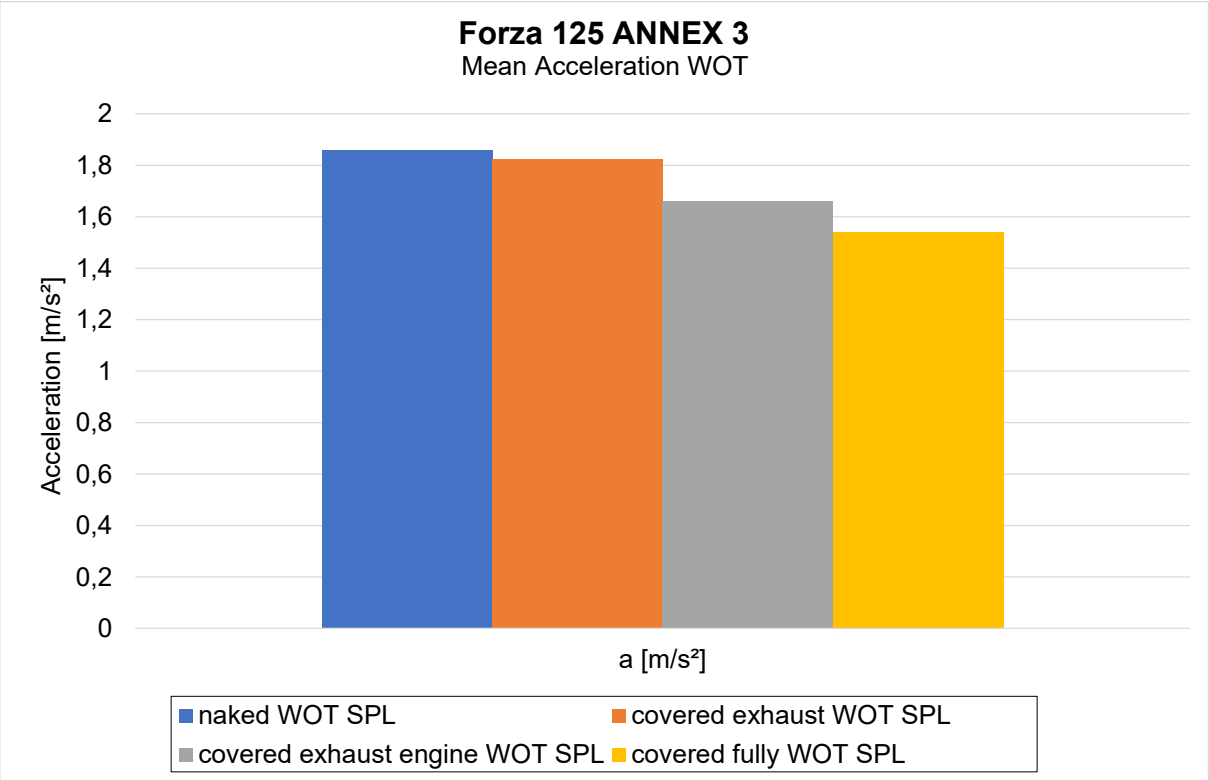

Figure 60: HONDA FORZA 125 ANNEX Acceleration WOT / Comparison noise damping variants

Honda Forza 125 Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

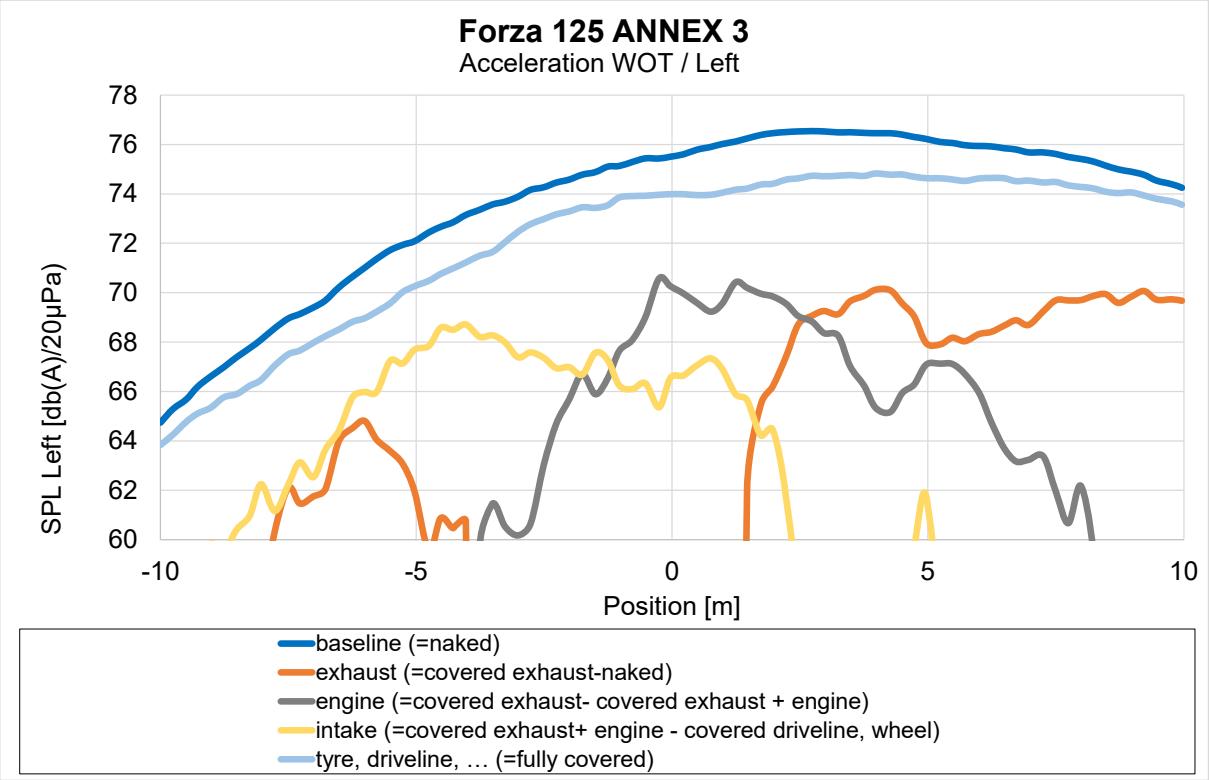

Figure 61: Honda Forza 125 Noise Contribution of Components Acceleration WOT left vehicle side

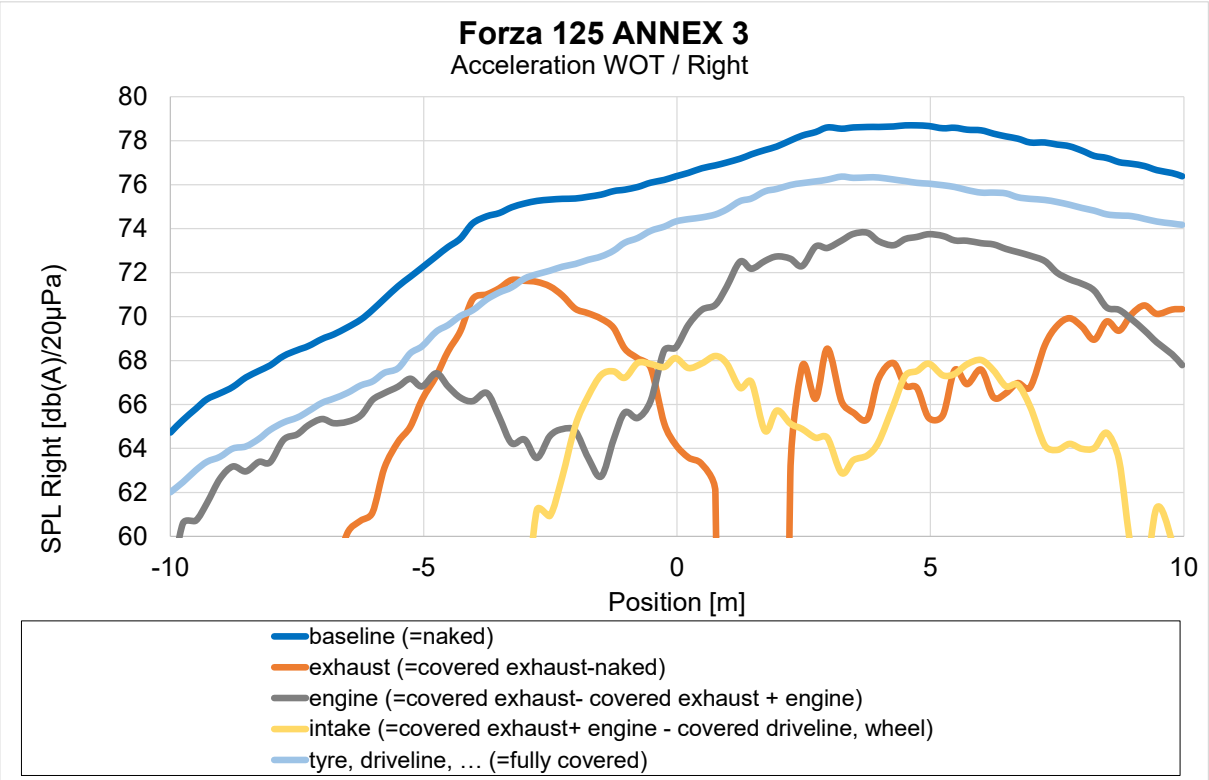

Figure 62: Honda Forza 125 Noise Contribution of Components Acceleration WOT right vehicle side

Table 40: Honda Forza 125: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT left vehicle side

Forza 125 ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	76,5
exhaust (=covered exhaust-naked)	70,1
engine (=covered exhaust- covered exhaust + engine)	70,6
intake (=covered exhaust+ engine - covered driveline, wheel)	68,7
tyre, driveline, … (=fully covered)	74,8

Table 41: Honda Forza 125: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT right vehicle side

Forza 125 ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	78,7
exhaust (=covered exhaust-naked)	71,7
engine (=covered exhaust- covered exhaust + engine)	73,8
intake (=covered exhaust+ engine - covered driveline, wheel)	68,2
tyre, driveline, … (=fully covered)	76,4

Honda Forza 125 Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

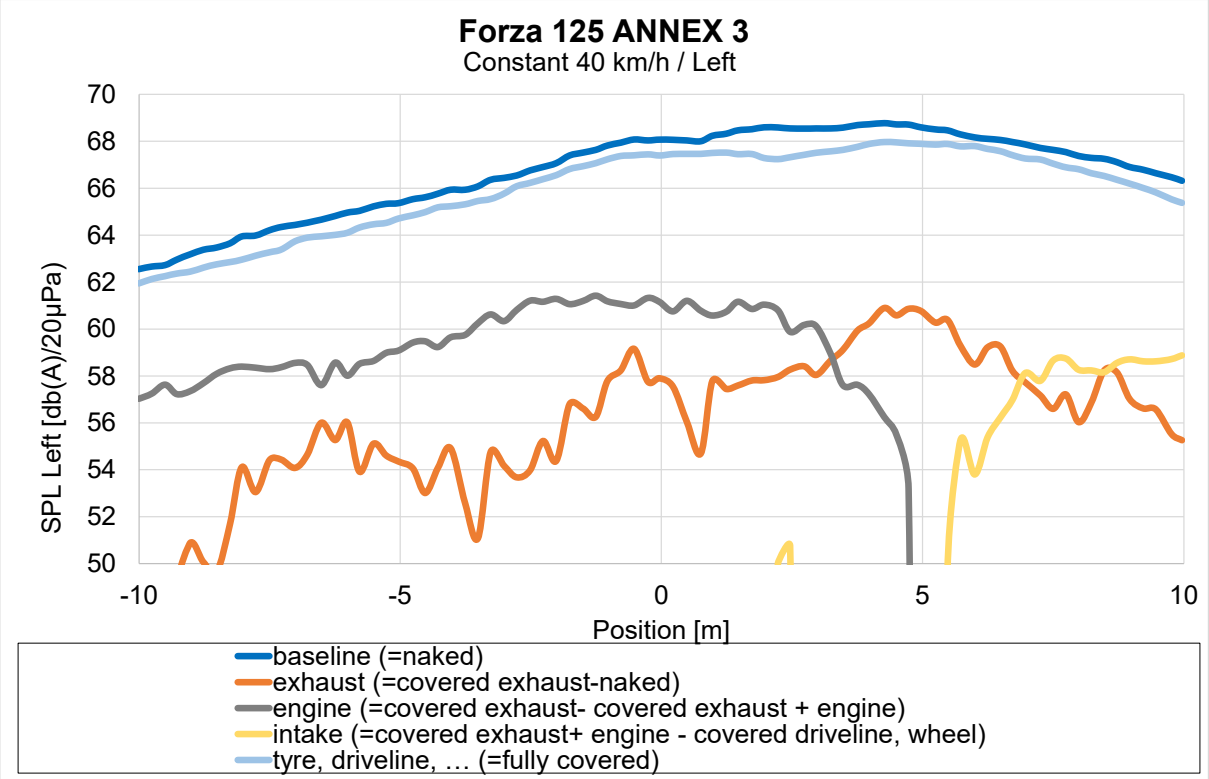

Figure 63: Honda Forza 125 Noise Contribution of Components Constant Speed 40 km/h left vehicle side

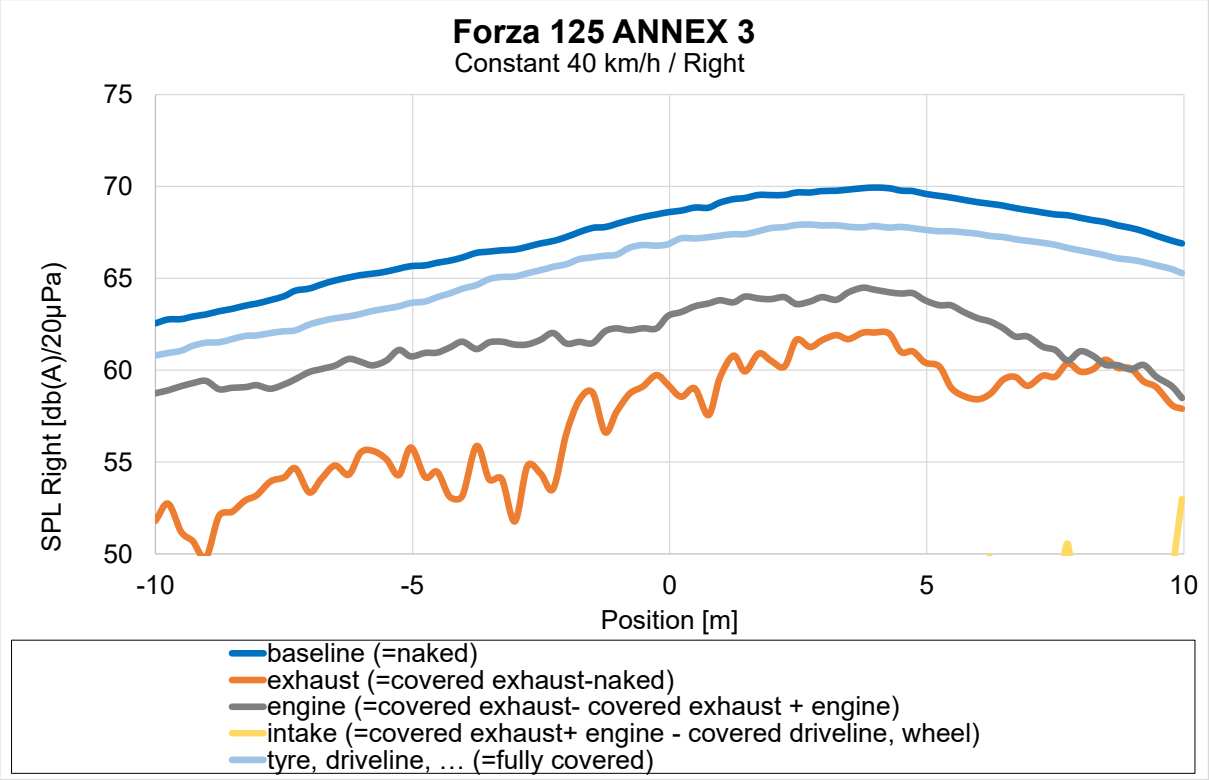

Figure 64: Honda Forza 125 Noise Contribution of Components Constant Speed 40 km/h right vehicle side

Table 42: Honda Forza 125: UNECE-R 41.04. / Annex 3: Noise Contribution of Constant Speed 40km/h left vehicle side

Forza 125 ANNEX 3 / Constant 40 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	68,8
exhaust (=covered exhaust-naked)	60,9
engine (=covered exhaust- covered exhaust + engine)	61,4
intake (=covered exhaust+ engine - covered driveline, wheel)	58,9
tyre, driveline, … (=fully covered)	68,0

Table 43: Honda Forza 125: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Constant Speed 40km/h right vehicle side

Forza 125 ANNEX 3 / Constant 40 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	69,9
exhaust (=covered exhaust-naked)	62,0
engine (=covered exhaust- covered exhaust + engine)	64,5
intake (=covered exhaust+ engine - covered driveline, wheel)	53,0
tyre, driveline, … (=fully covered)	67,9

5.4. Kawasaki Vulcan S

Kawasaki Vulcan S Overall Results UNECE-R 41.04. / Annex 3

Table 44: Measurement result Kawasaki Vulcan S UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

Vulcan ANNEX 3								
Lurban	**Lwot,rep**	**Lcrs,rep**	**a urban [m/s²]**	**a wot,ref [m/s²]**	**kp**	**k**	**Calc. Type**	**PMR**
74,4	78,1	68,1	1,58	3,06	0,37	0	R41 rev3	147.0

Table 45: Measurement result Kawasaki Vulcan S UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

Vulcan ANNEX 3				
	L [dB(A)]	**Lmax L [dB(A)]**	**Lmax R [dB(A)]**	**a [m/s²]**
Acceleration WOT	78,1	78	78,1	2,52
Constant 50 km/h	68,1	67,5	68,1	0,20

Kawasaki Vulcan S Reference Measurements Vehicle Speed & Acceleration

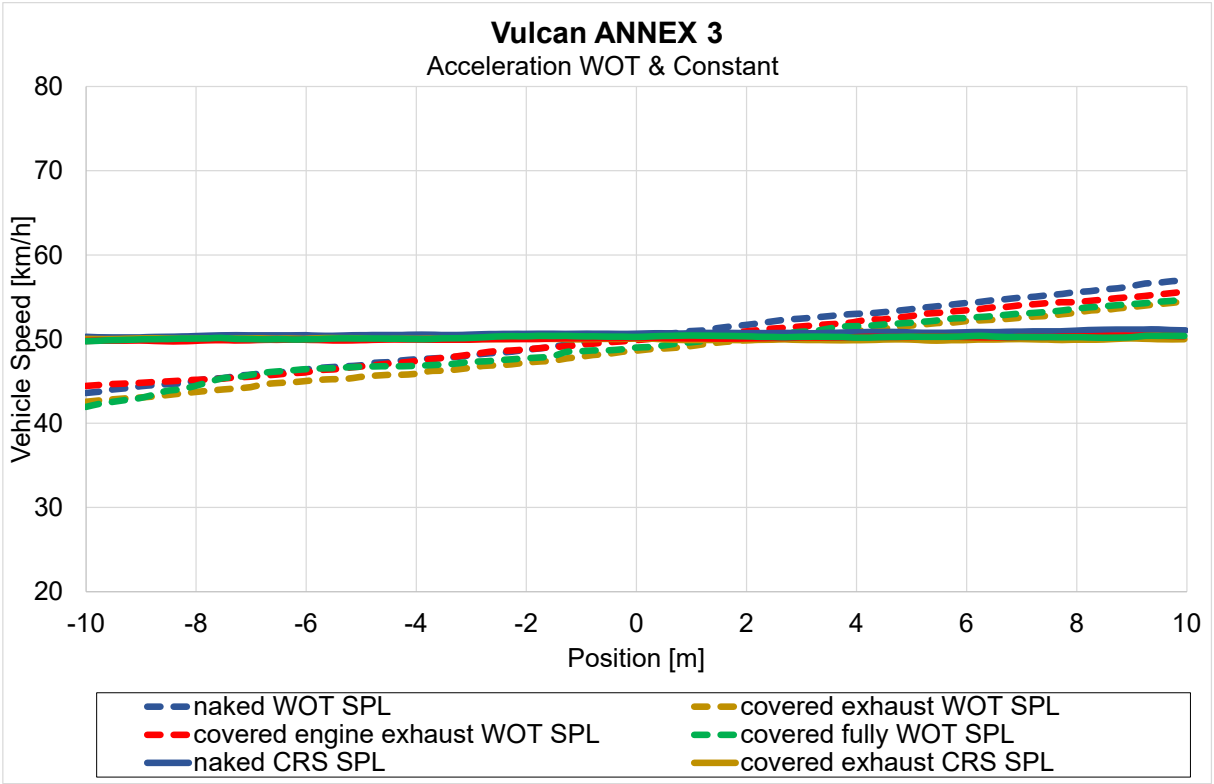

Figure 65: Kawasaki Vulcan S Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

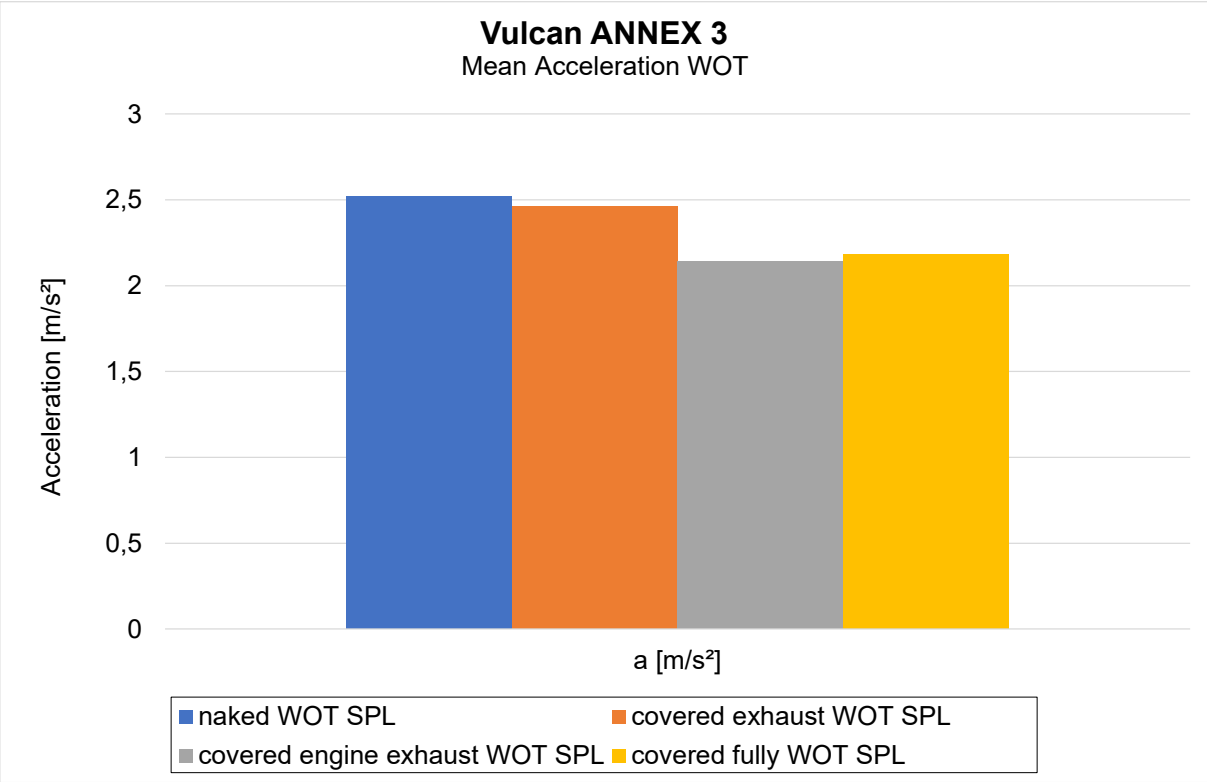

Figure 66: Kawasaki Vulcan S WOT / Comparison noise damping variants

Kawasaki Vulcan S Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

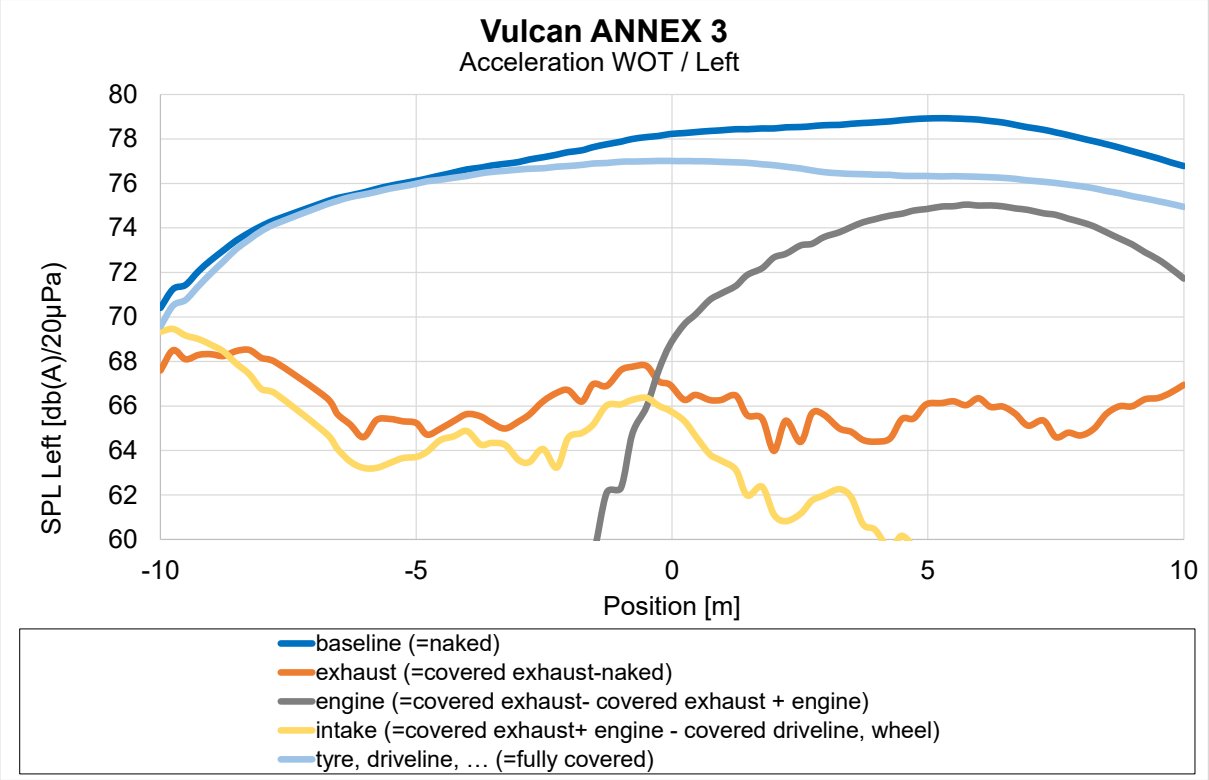

Figure 67: Kawasaki Vulcan S Noise Contribution of Components 4th Gear Acceleration WOT left vehicle side

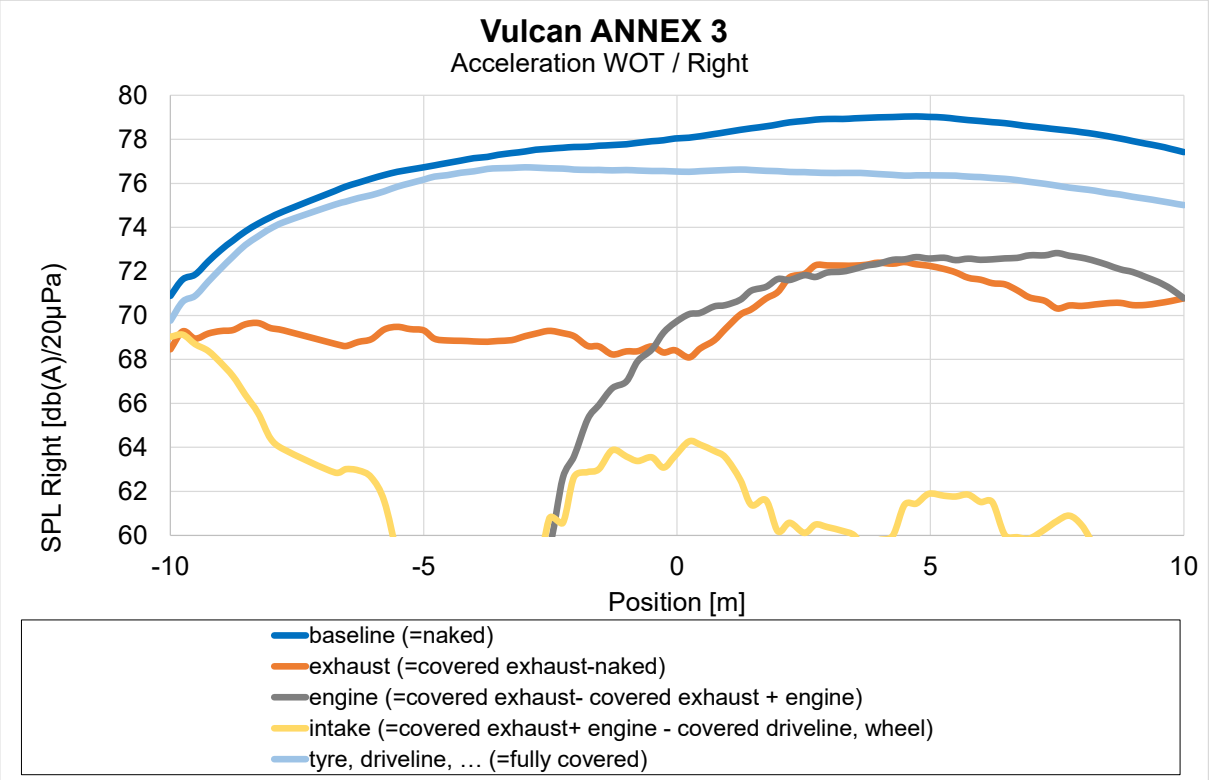

Figure 68: Kawasaki Vulcan S Noise Contribution of Components 4th Gear Acceleration WOT right vehicle side

Table 46: Kawasaki Vulcan S UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Acceleration WOT left vehicle side

Vulcan ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	78,9
exhaust (=covered exhaust-naked)	68,5
engine (=covered exhaust- covered exhaust + engine)	75,0
intake (=covered exhaust+ engine - covered driveline, wheel)	69,5
tyre, driveline, … (=fully covered)	77,0

Table 47: Kawasaki Vulcan S: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Acceleration WOT right vehicle side

Vulcan ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	79,0
exhaust (=covered exhaust-naked)	72,4
engine (=covered exhaust- covered exhaust + engine)	72,8
intake (=covered exhaust+ engine - covered driveline, wheel)	69,1
tyre, driveline, … (=fully covered)	76,7

Kawasaki Vulcan S Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

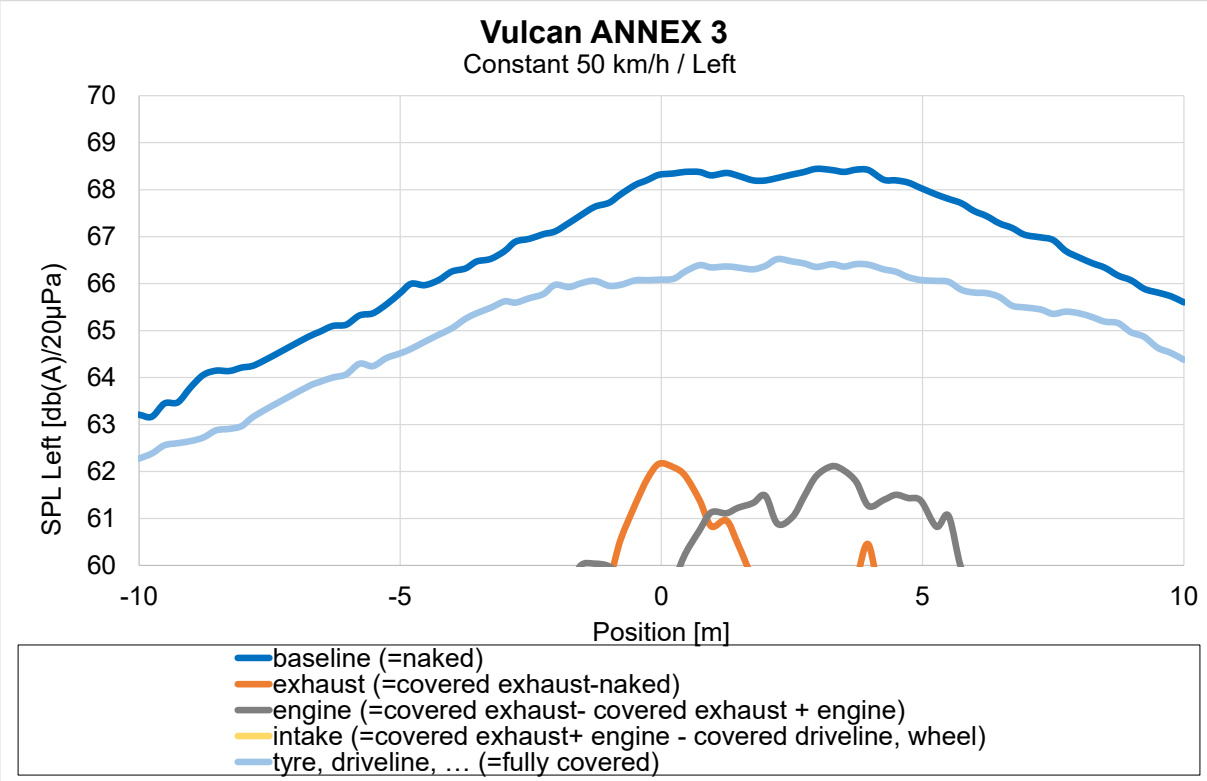

Figure 69: Kawasaki Vulcan S Noise Contribution of Components 4th Gear Constant Speed 50 km/h left vehicle side

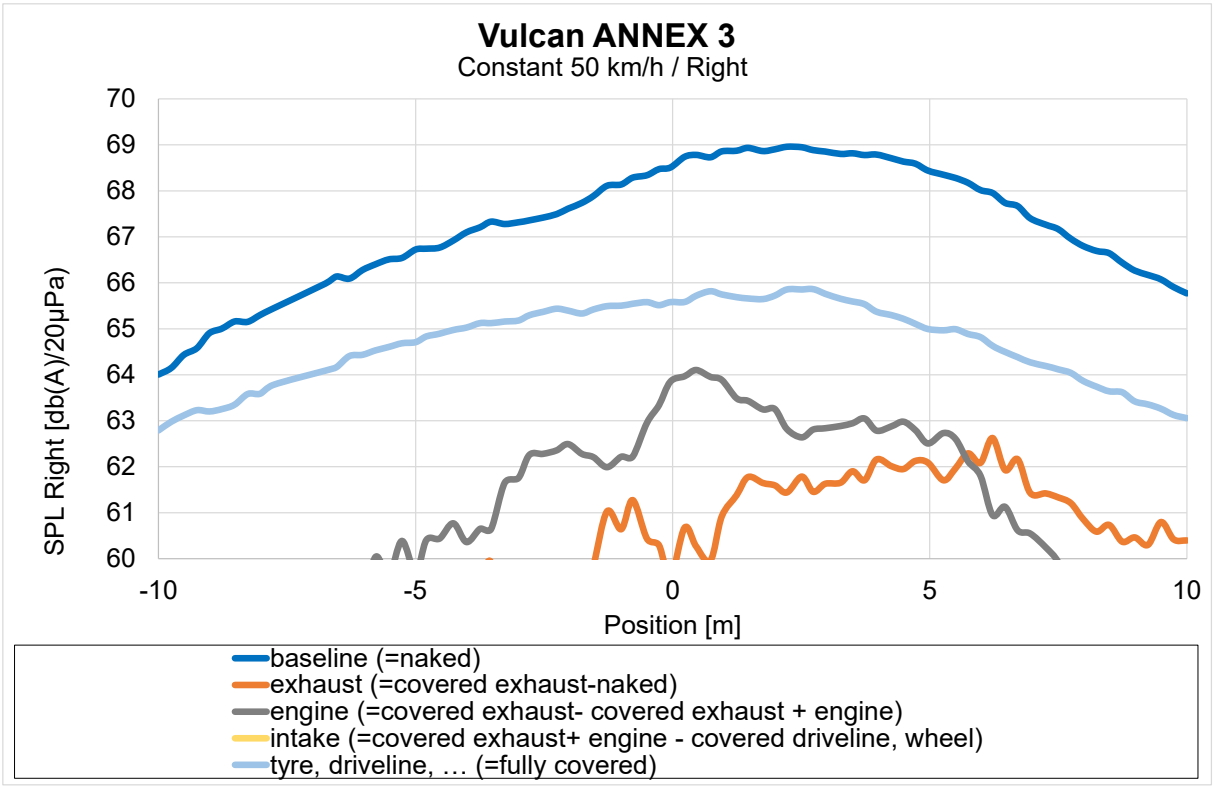

Figure 70: Kawasaki Vulcan S Noise Contribution of Components 4th Gear Constant Speed 50 km/h right vehicle side

Table 48: Kawasaki Vulcan S: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Constant Speed 50km/h left vehicle side

Vulcan ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	68,4
exhaust (=covered exhaust-naked)	62,2
engine (=covered exhaust- covered exhaust + engine)	62,1
intake (=covered exhaust+ engine - covered driveline, wheel)	55,1
tyre, driveline, … (=fully covered)	66,5

Table 49: Kawasaki Vulcan S: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 4th Gear Constant Speed 50km/h right vehicle side

Vulcan ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	69,0
exhaust (=covered exhaust-naked)	62,6
engine (=covered exhaust- covered exhaust + engine)	64,1
intake (=covered exhaust+ engine - covered driveline, wheel)	58,5
tyre, driveline, … (=fully covered)	65,9

5.5. KTM 390 Duke

KTM 390 Duke Overall Results UNECE-R 41.04. / Annex 3

Table 50: Measurement result KTM 390 Duke UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

KTM390 ANNEX 3								
Lurban	**Lwot,rep**	**Lcrs,rep**	**a urban [m/s²]**	**a wot,ref [m/s²]**	**kp**	**k**	**Calc. Type**	**PMR**
74,7	77,1	71,5	1,54	2,93	0,42	-	R41 rev3	135.0

Table 51: Measurement result KTM 390 Duke UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

KTM390 ANNEX 3				
	L [dB(A)]	**Lmax L [dB(A)]**	**Lmax R [dB(A)]**	**a [m/s²]**
Acceleration WOT 3rd	77,1	76,5	77,1	2,66
Constant 50 km/h 3rd	71,5	71,5	71,1	0,05

KTM 390 Duke Reference Measurements Vehicle Speed & Acceleration

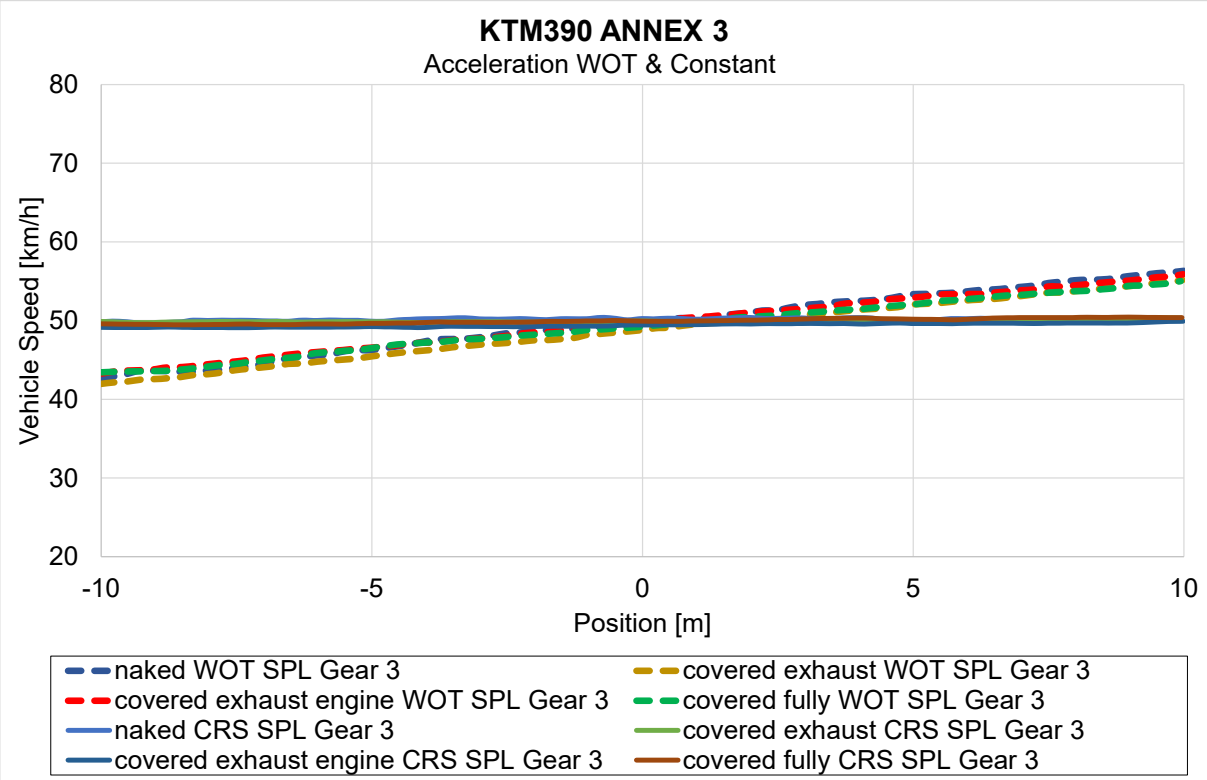

Figure 71: KTM 390 Duke Vehicle Speed for Acceleration WOT & Constant Speed 3rd Gear: Comparison noise damping variants

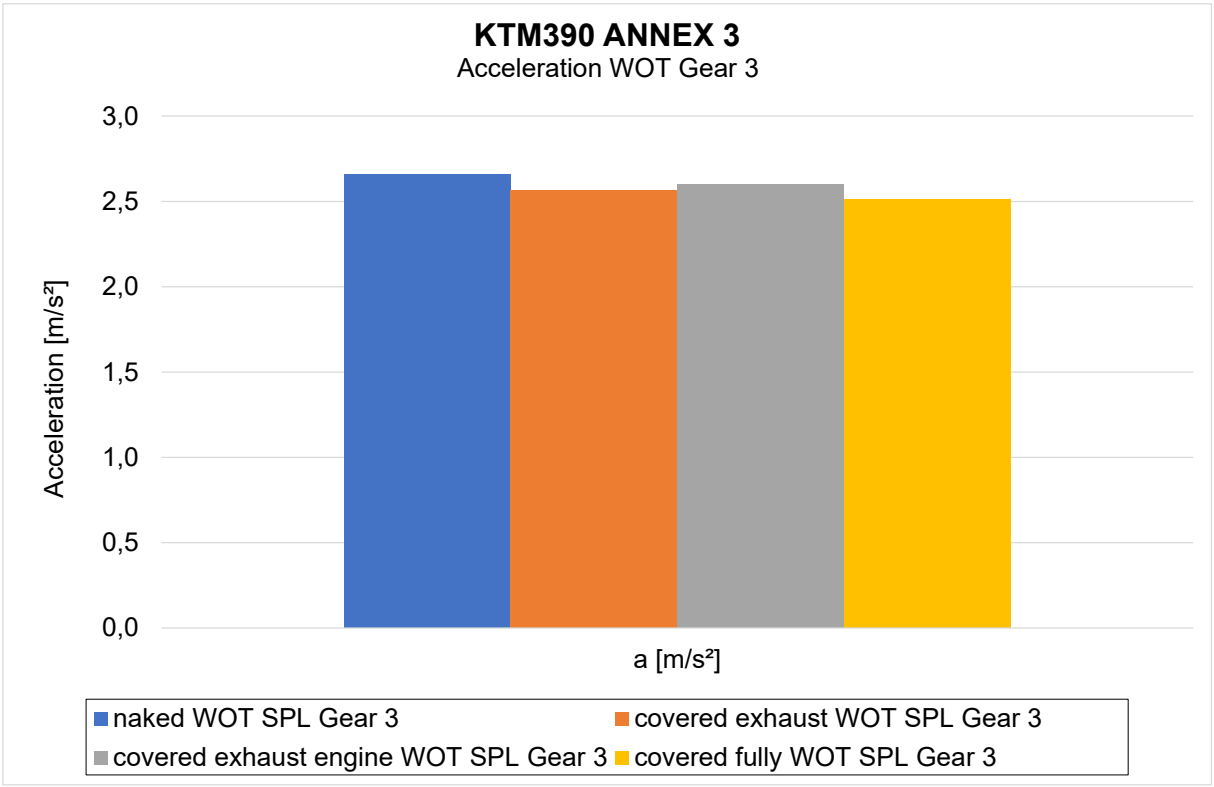

Figure 72: KTM 390 Duke Acceleration WOT 3rd Gear / Comparison noise damping variants

KTM 390 Duke Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

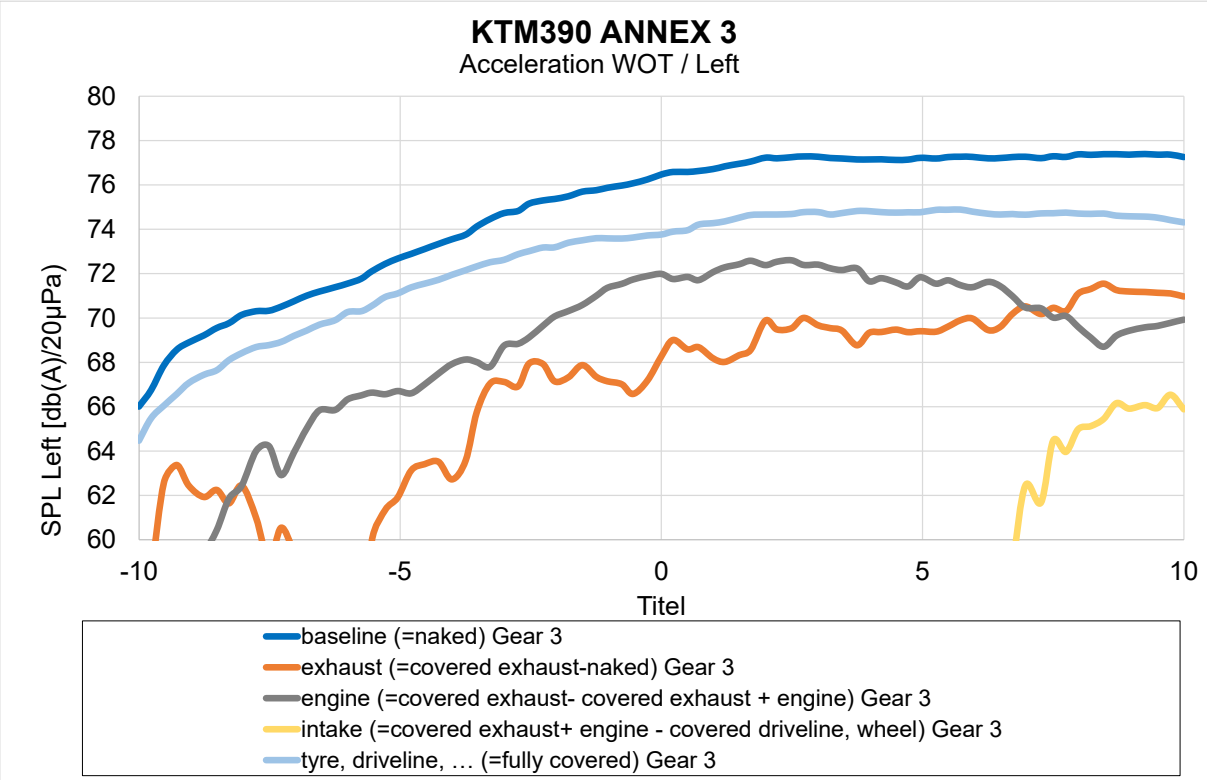

Figure 73: KTM 390 Duke Noise Contribution of Components 3rd Gear Acceleration WOT left vehicle side

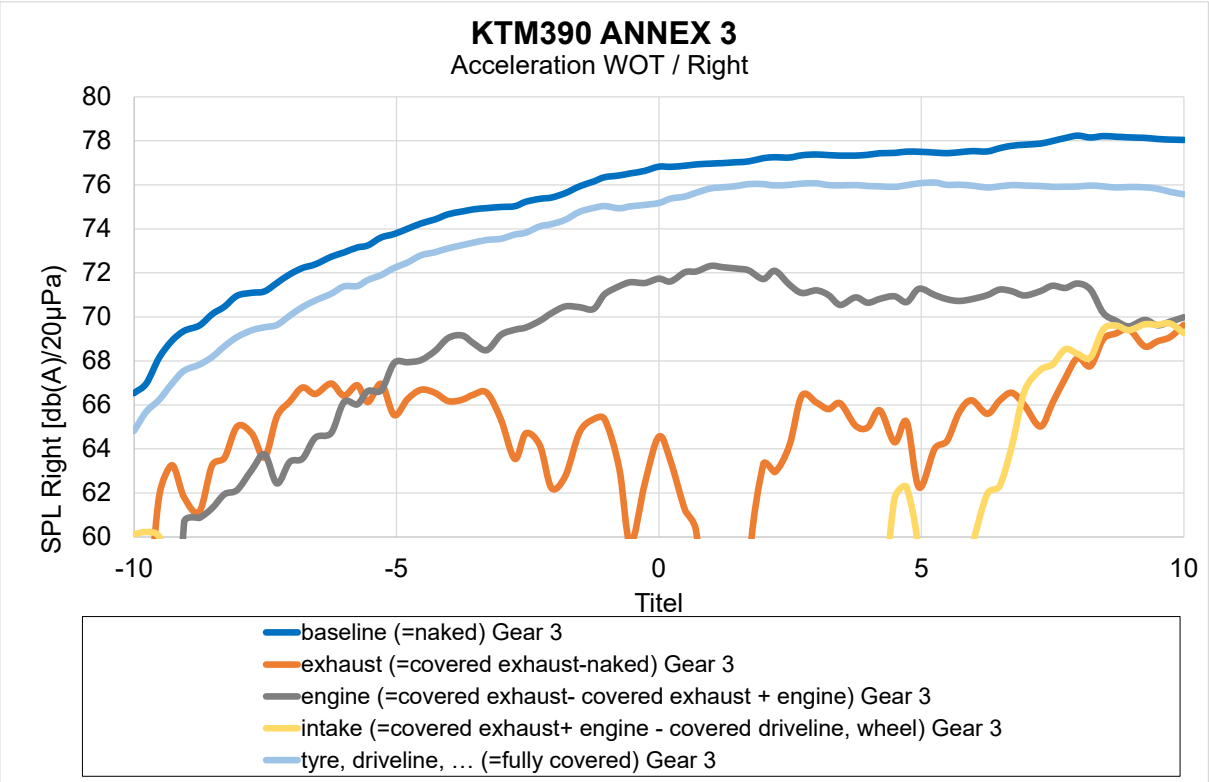

Figure 74: KTM 390 Duke Noise Contribution of Components 3rd Gear Acceleration WOT right vehicle side

Table 52: KTM 390 Duke: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Acceleration WOT left vehicle side

KTM390 ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked) Gear 3	77,4
exhaust (=covered exhaust-naked) Gear 3	71,5
engine (=covered exhaust- covered exhaust + engine) Gear 3	72,6
intake (=covered exhaust+ engine - covered driveline, wheel) (	66,5
tyre, driveline, … (=fully covered) Gear 3	74,9

Table 53: KTM 390 Duke: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Acceleration WOT right vehicle side

KTM390 ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked) Gear 3	78,2
exhaust (=covered exhaust-naked) Gear 3	69,6
engine (=covered exhaust- covered exhaust + engine) Gear 3	72,3
intake (=covered exhaust+ engine - covered driveline, wheel) (	69,7
tyre, driveline, … (=fully covered) Gear 3	76,1

KTM 390 Duke Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

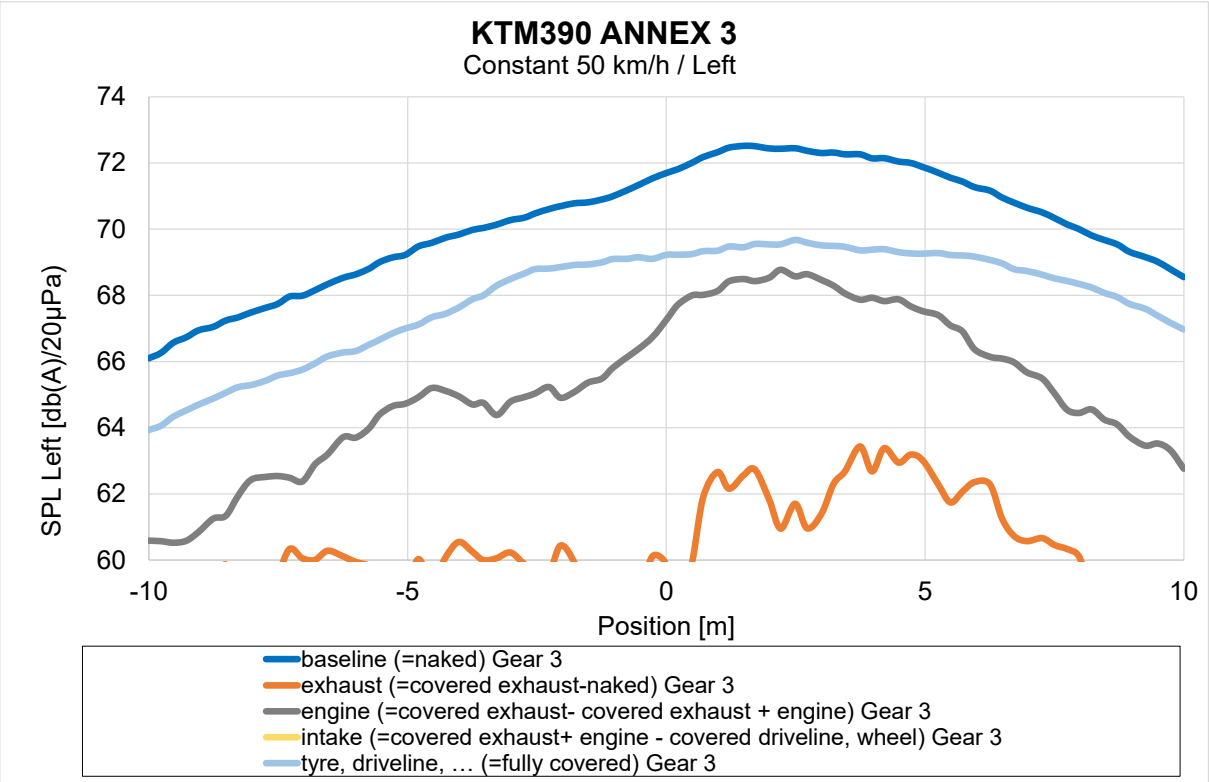

Figure 75: Noise Contribution of Components 3rd Gear Constant Speed 50 km/h left vehicle side

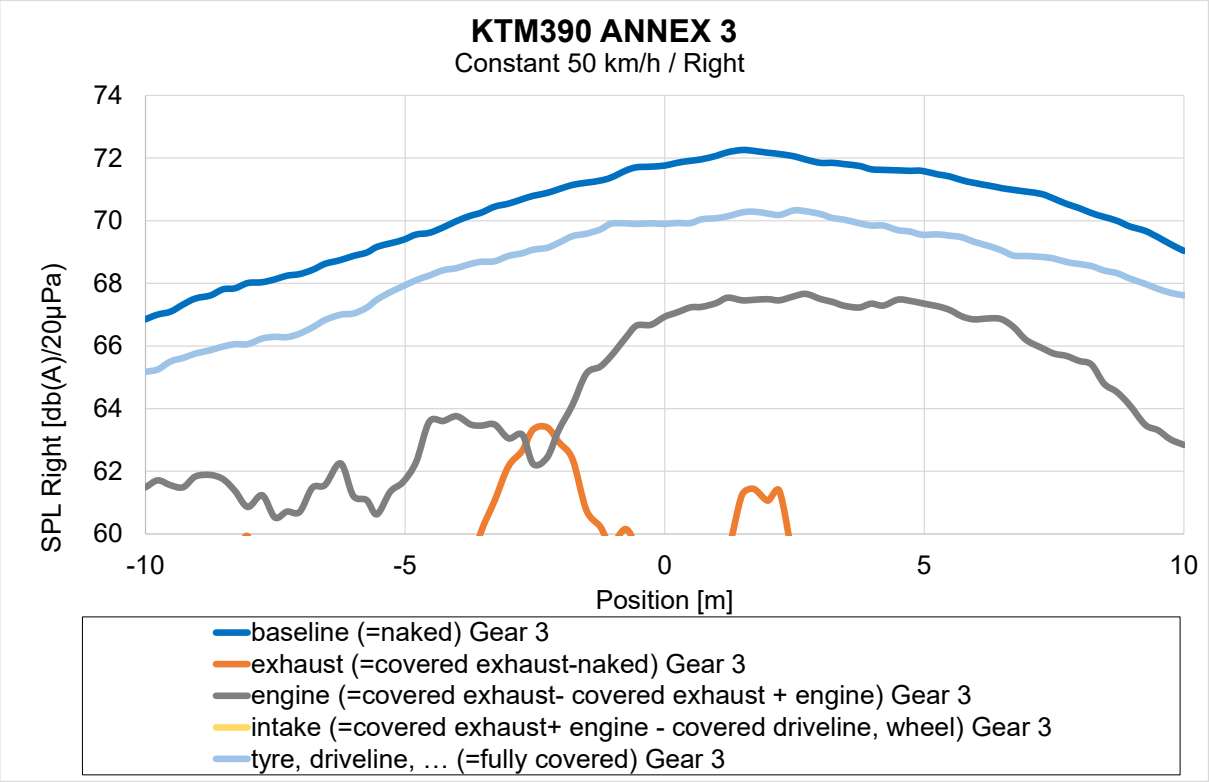

Figure 76: Noise Contribution of Components 3rd Gear Constant Speed 50 km/h right vehicle side

Table 54: KTM 390 Duke: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Constant Speed 50km/h left vehicle side

KTM390 ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked) Gear 3	72,5
exhaust (=covered exhaust-naked) Gear 3	63,4
engine (=covered exhaust- covered exhaust + engine) Gear 3	68,8
intake (=covered exhaust+ engine - covered driveline, wheel) (	55,5
tyre, driveline, … (=fully covered) Gear 3	69,7

Table 55: KTM 390 Duke: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Constant Speed 50km/h right vehicle side

KTM390 ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked) Gear 3	72,3
exhaust (=covered exhaust-naked) Gear 3	63,4
engine (=covered exhaust- covered exhaust + engine) Gear 3	67,7
intake (=covered exhaust+ engine - covered driveline, wheel) (	58,1
tyre, driveline, … (=fully covered) Gear 3	70,3

5.6. Piaggio Vespa 300 GT

Piaggio Vespa 300 GT Overall Results UNECE-R 41.04. / Annex 3

Table 56: Measurement result Piaggio Vespa 300 GT UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

Piaggio Vespa 300 GT ANNEX 3								
Lurban	Lwot,rep	Lcrs,rep	a urban [m/s²]	a wot,ref [m/s²]	kp	k	Calc. Type	PMR
74,8	80,3	70,8	1,09	1,76	0,58	0	R41 rev3	60.1

Table 57: Measurement result Piaggio Vespa 300 GT UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

Piaggio Vespa 300 GT ANNEX 3				
	L [dB(A)]	Lmax L [dB(A)]	Lmax R [dB(A)]	a [m/s²]
Acceleration WOT	80,3	80,3	79,4	2,58
Constant 50 km/h	70,8	70,8	68,3	0,16

Piaggio Vespa 300 GT Reference Measurements Vehicle Speed & Acceleration

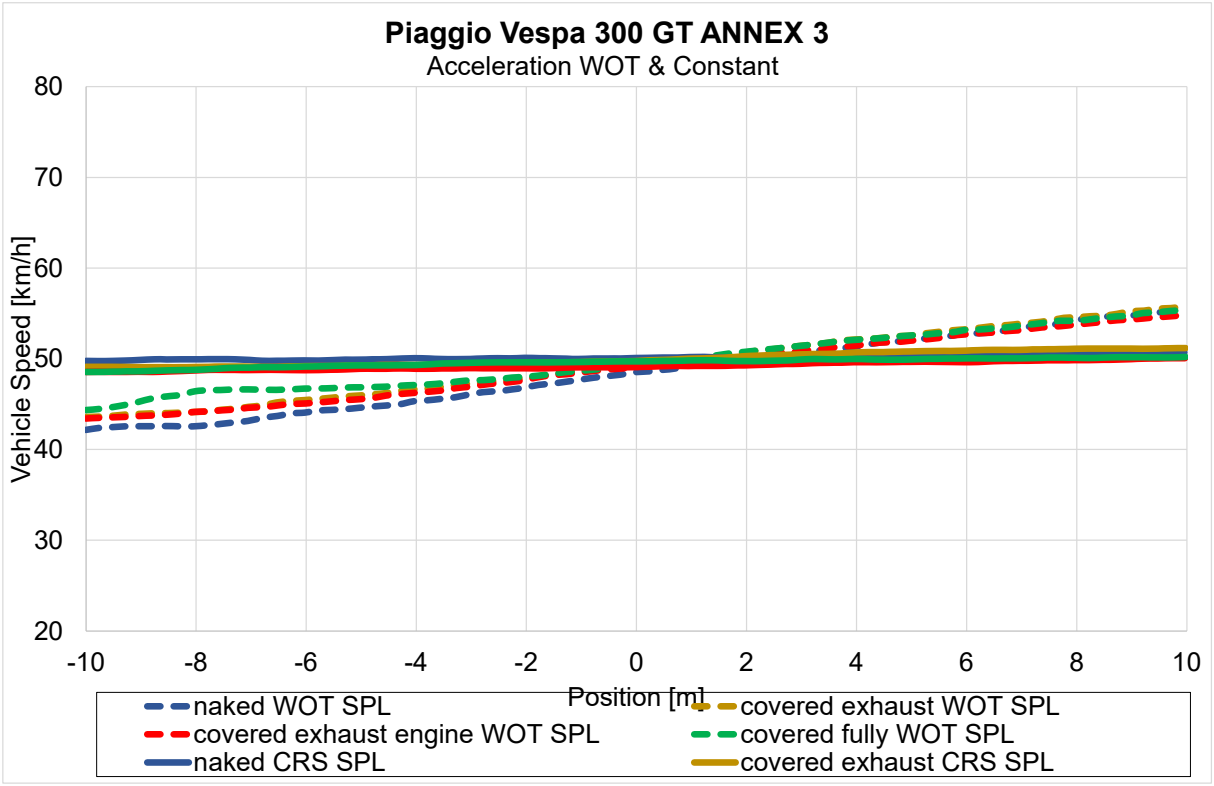

Figure 77: Piaggio Vespa 300 GT ANNEX Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

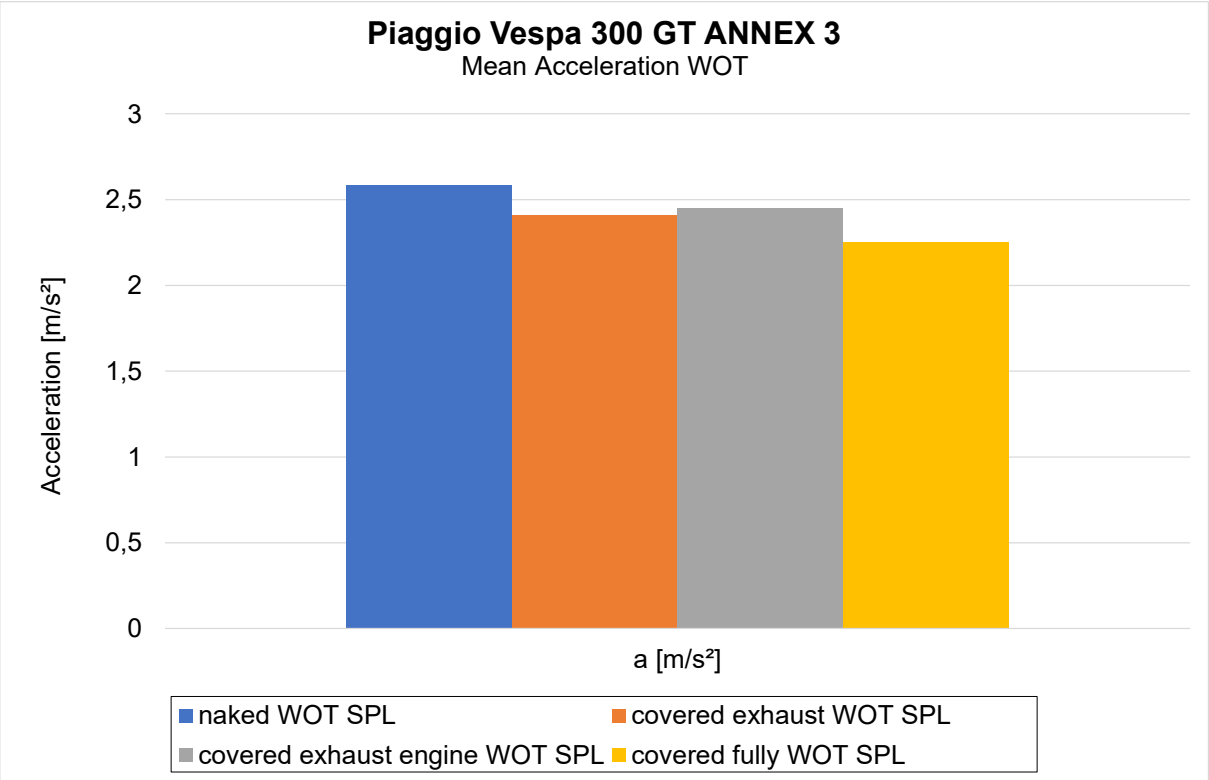

Figure 78: Piaggio Vespa 300 GT ANNEX Acceleration WOT / Comparison noise damping variants

Piaggio Vespa 300 GT Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

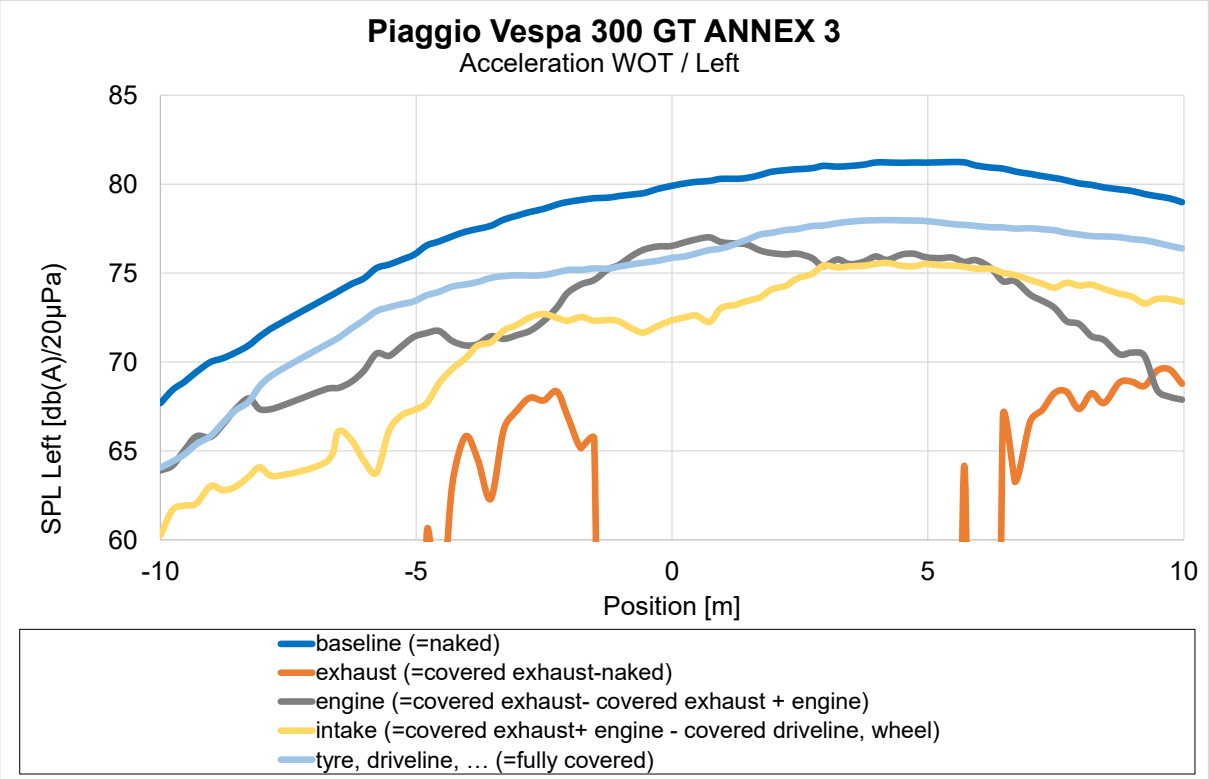

Figure 79: Piaggio Vespa 300 GT Noise Contribution of Components Acceleration WOT left vehicle side

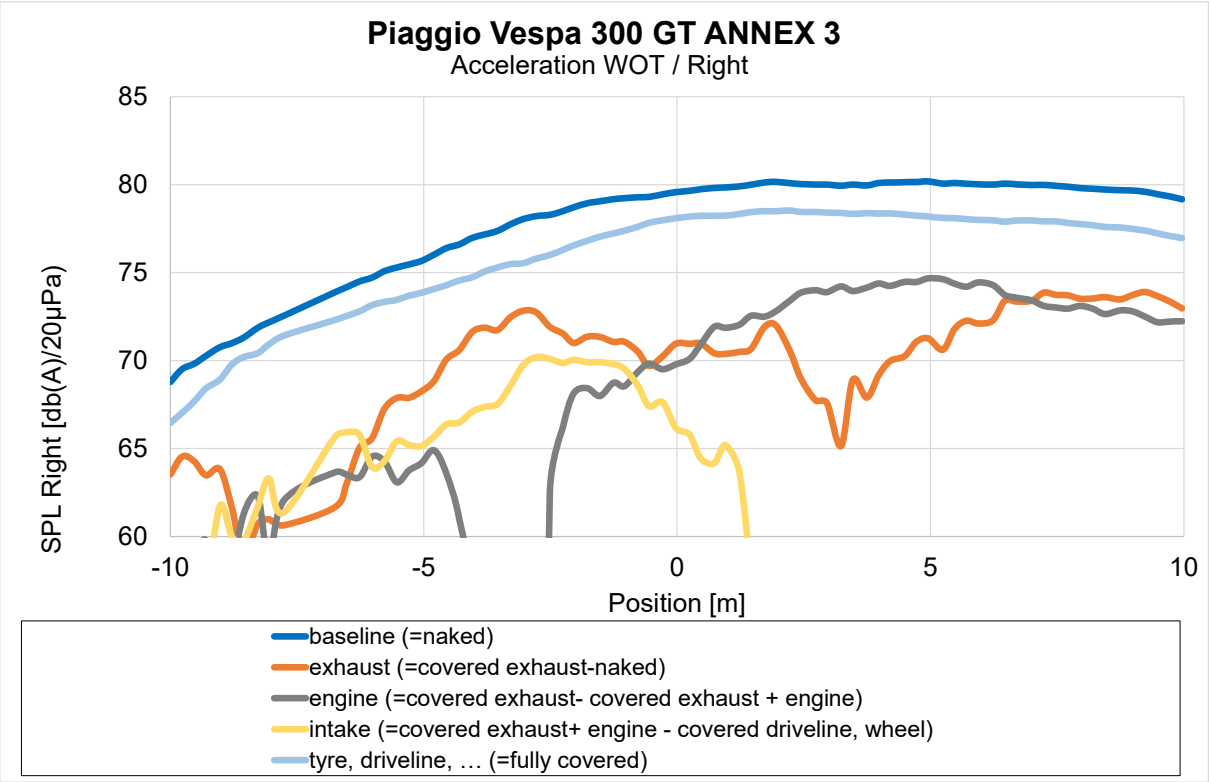

Figure 80: Piaggio Vespa 300 GT Noise Contribution of Components Acceleration WOT right vehicle side

Table 58: Piaggio Vespa 300 GT: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT left vehicle side

Piaggio Vespa 300 GT ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	81,2
exhaust (=covered exhaust-naked)	69,6
engine (=covered exhaust- covered exhaust + engine)	77,0
intake (=covered exhaust+ engine - covered driveline, wheel)	75,6
tyre, driveline, … (=fully covered)	78,0

Table 59: Piaggio Vespa 300 GT: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT right vehicle side

Piaggio Vespa 300 GT ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	80,2
exhaust (=covered exhaust-naked)	73,9
engine (=covered exhaust- covered exhaust + engine)	74,7
intake (=covered exhaust+ engine - covered driveline, wheel)	70,2
tyre, driveline, … (=fully covered)	78,5

Piaggio Vespa 300 GT Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

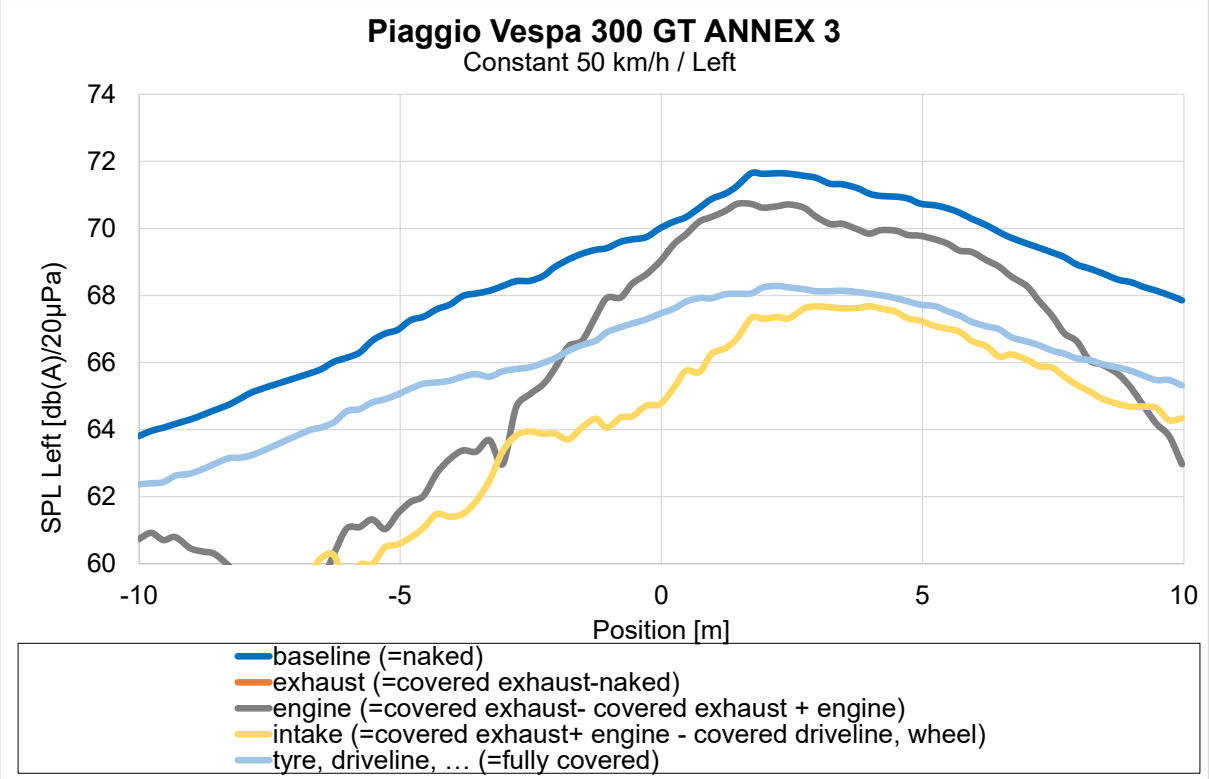

Figure 81: Piaggio Vespa 300 GT Noise Contribution of Components Constant Speed 40 km/h left vehicle side

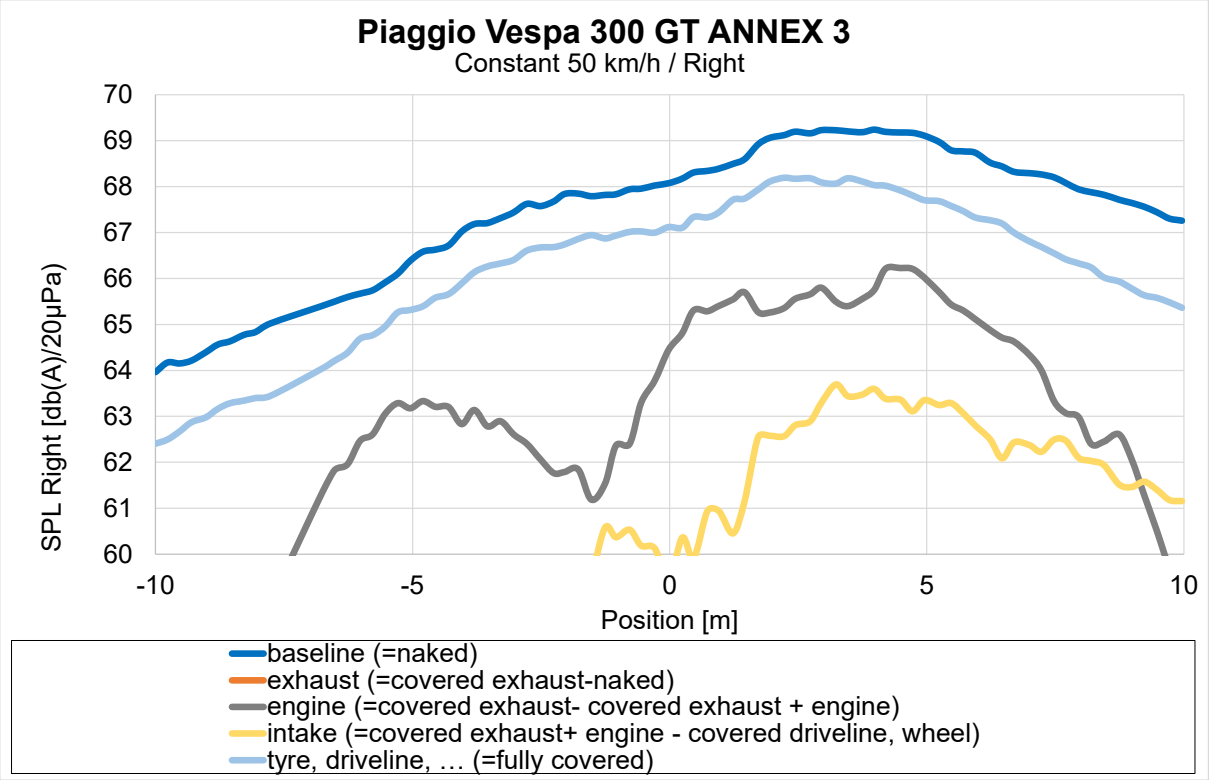

Figure 82: Piaggio Vespa 300 GT Noise Contribution of Components Constant Speed 40 km/h right vehicle side

Table 60: Piaggio Vespa 300 GT: UNECE-R 41.04. / Annex 3: Noise Contribution of Constant Speed 40km/h left vehicle side

Piaggio Vespa 300 GT ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	71,6
exhaust (=covered exhaust-naked)	0,0
engine (=covered exhaust- covered exhaust + engine)	70,7
intake (=covered exhaust+ engine - covered driveline, wheel)	67,7
tyre, driveline, … (=fully covered)	68,3

Table 61: Piaggio Vespa 300 GT: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Constant Speed 40km/h right vehicle side

Piaggio Vespa 300 GT ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	69,2
exhaust (=covered exhaust-naked)	57,2
engine (=covered exhaust- covered exhaust + engine)	66,2
intake (=covered exhaust+ engine - covered driveline, wheel)	63,7
tyre, driveline, … (=fully covered)	68,2

5.7. Triumph Street Triple R

Triumph Street Triple R Overall Results UNECE-R 41.04. / Annex 3

Table 62: Measurement result Triumph Street Triple R UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

Street TripleR ANNEX 3								
Lurban	Lwot,rep	Lcrs,rep	a urban [m/s²]	a wot,ref [m/s²]	kp	k	Calc. Type	PMR
76,7	80,4	73,3	2,04	4,23	0,52	0	R41 rev3	331

Table 63: Measurement result Triumph Street Triple R UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

Street TripleR ANNEX 3				
	L [dB(A)]	Lmax L [dB(A)]	Lmax R [dB(A)]	a [m/s²]
Acceleration WOT	80,4	80,4	80,3	4,20
Constant 50 km/h	73,3	73,3	71,7	0,01

Triumph Street Triple R Reference Measurements Vehicle Speed & Acceleration

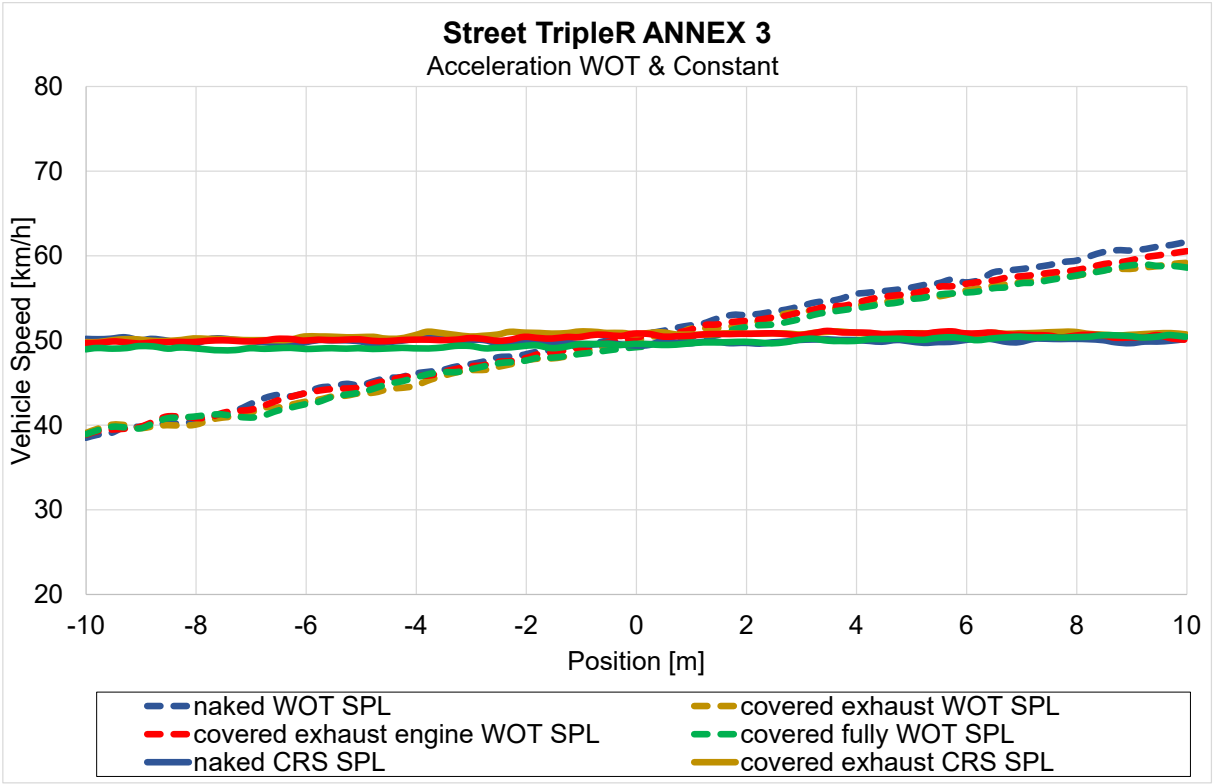

Figure 83: Triumph Street Triple R Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

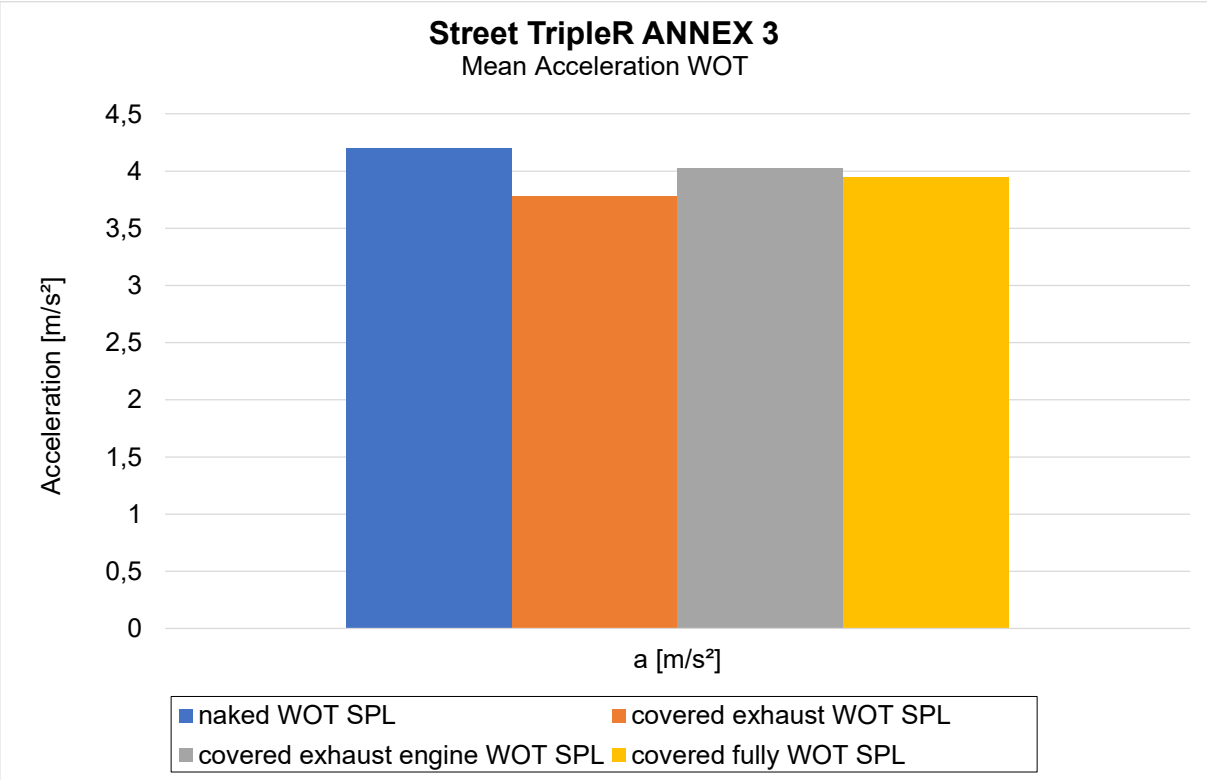

Figure 84: Triumph Street Triple R Acceleration WOT / Comparison noise damping variants

Triumph Street Triple R Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

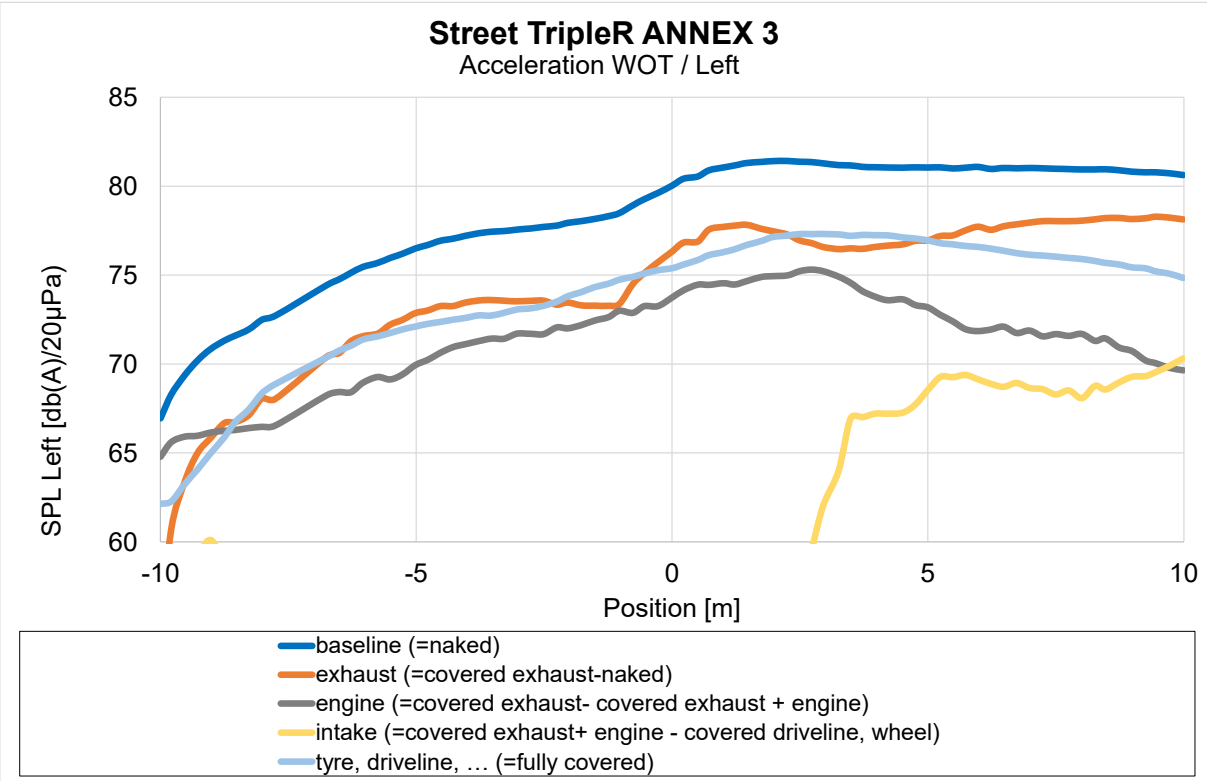

Figure 85: Triumph Street Triple R Noise Contribution of Components 3rd Gear Acceleration WOT left vehicle side

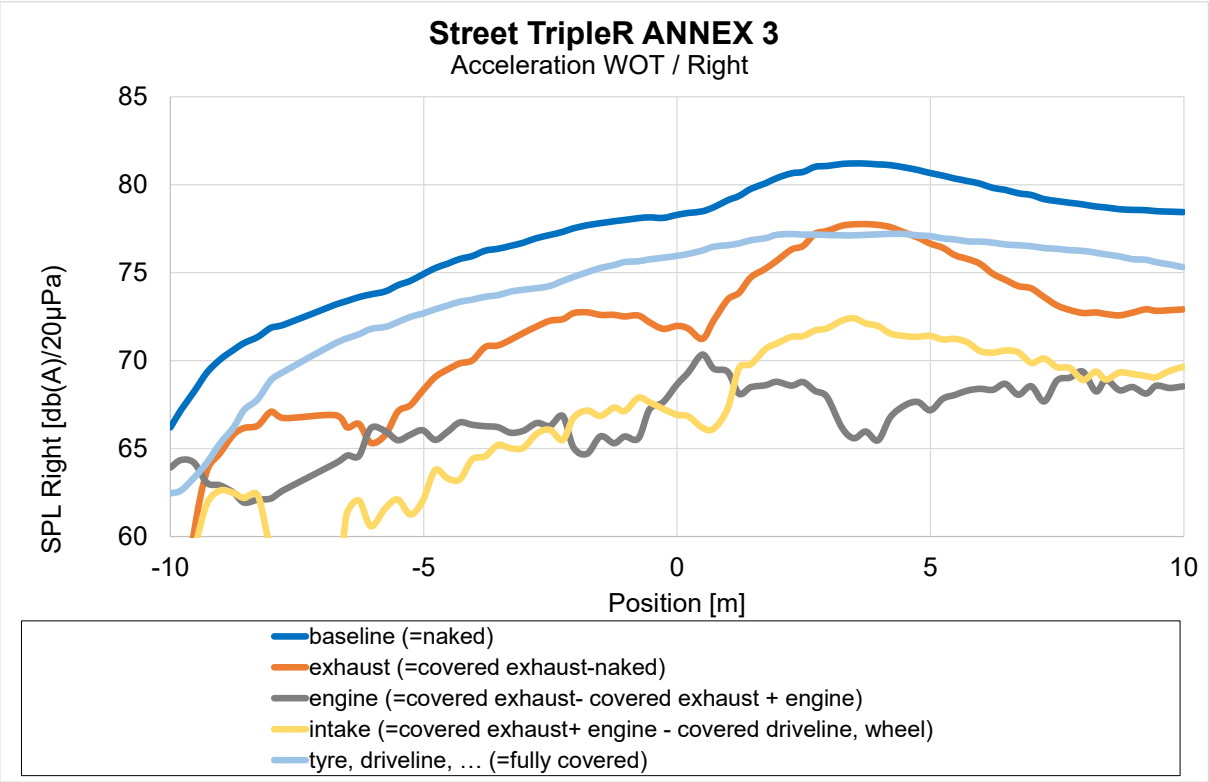

Figure 86: Triumph Street Triple R Noise Contribution of Components 3rd Gear Acceleration WOT right vehicle side

Table 64: Triumph Street Triple R: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Acceleration WOT left vehicle side

Street TripleR ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	80,4
exhaust (=covered exhaust-naked)	77,3
engine (=covered exhaust- covered exhaust + engine)	74,3
intake (=covered exhaust+ engine - covered driveline, wheel)	69,3
tyre, driveline, … (=fully covered)	76,3

Table 65: Triumph Street Triple R: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Acceleration WOT right vehicle side

Street TripleR ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	80,2
exhaust (=covered exhaust-naked)	76,8
engine (=covered exhaust- covered exhaust + engine)	69,3
intake (=covered exhaust+ engine - covered driveline, wheel)	71,4
tyre, driveline, … (=fully covered)	76,2

Triumph Street Triple R Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

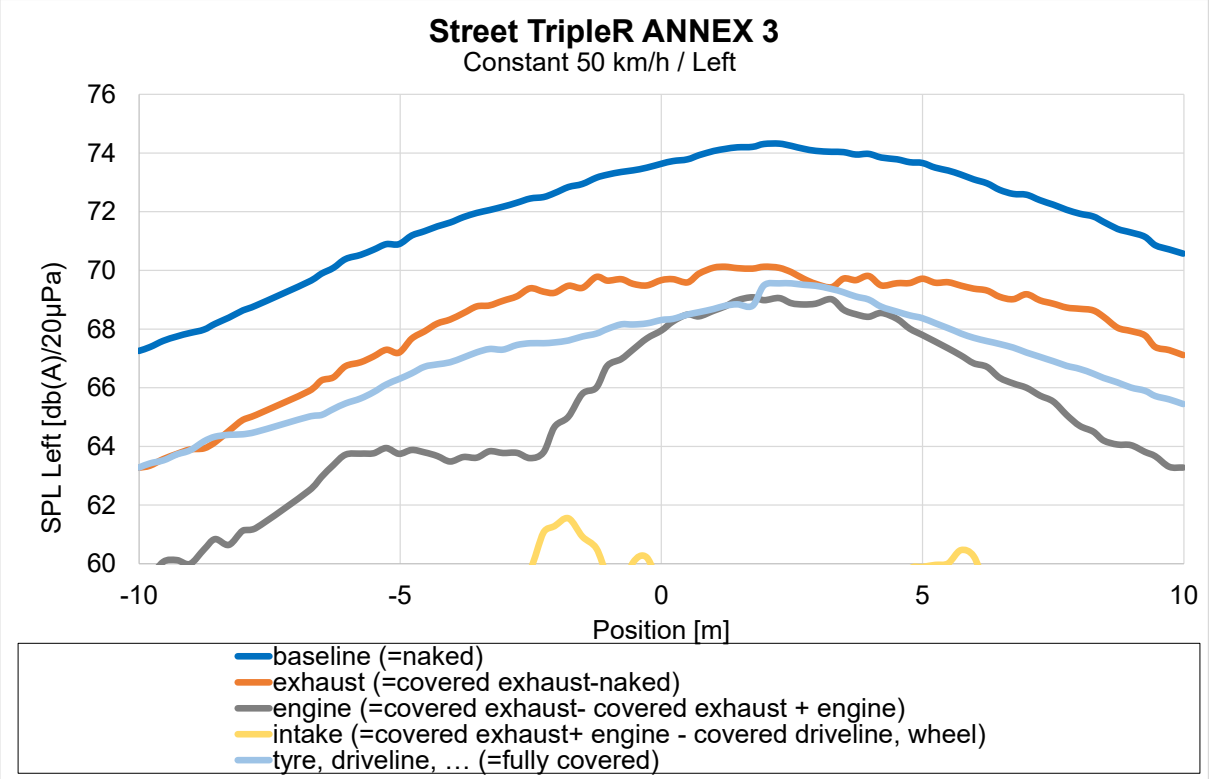

Figure 87: Triumph Street Triple R Noise Contribution of Components 3rd Gear Constant Speed 50 km/h left vehicle side

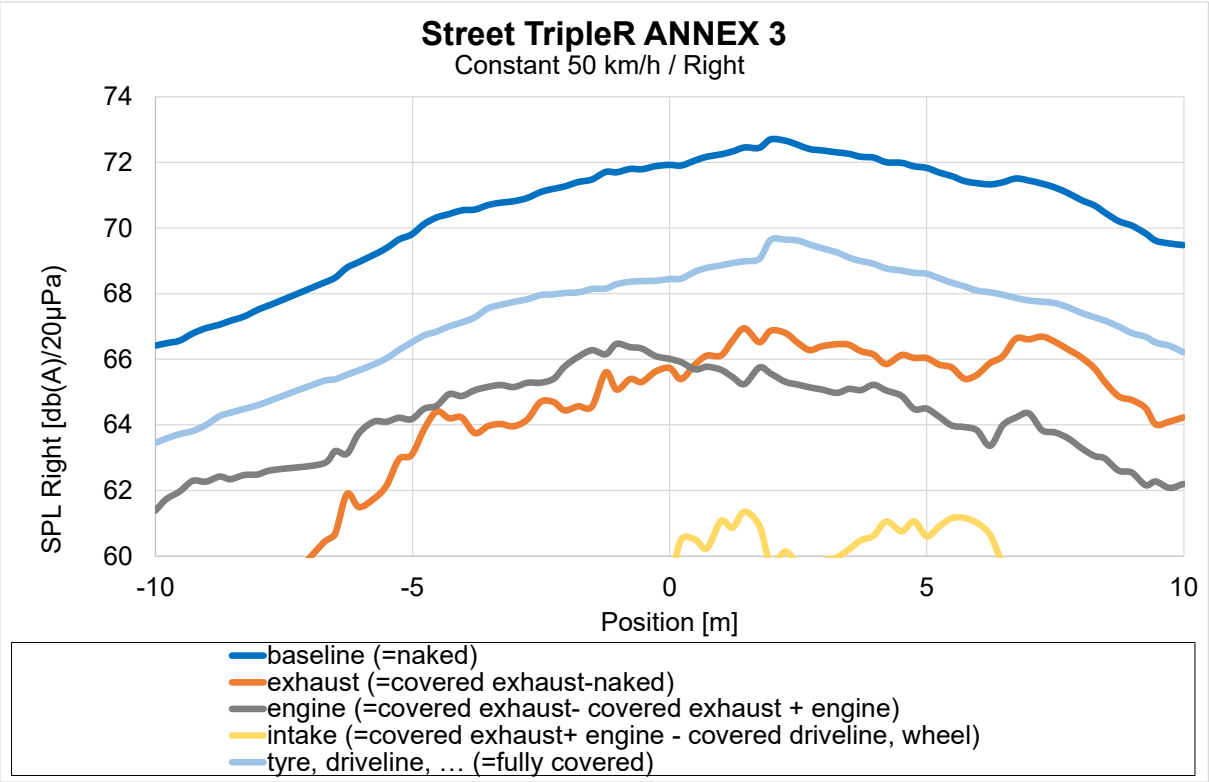

Figure 88: Triumph Street Triple R Noise Contribution of Components 3rd Gear Constant Speed 50 km/h right vehicle side

Table 66: Triumph Street Triple R: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Constant Speed 50km/h left vehicle side

Street TripleR ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	73,3
exhaust (=covered exhaust-naked)	69,1
engine (=covered exhaust- covered exhaust + engine)	68,1
intake (=covered exhaust+ engine - covered driveline, wheel)	60,5
tyre, driveline, ... (=fully covered)	68,6

Table 67: Triumph Street Triple R: UNECE-R 41.04. / Annex 3: Noise Contribution of Components 3rd Gear Constant Speed 50km/h right vehicle side

Street TripleR ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	71,7
exhaust (=covered exhaust-naked)	65,9
engine (=covered exhaust- covered exhaust + engine)	65,5
intake (=covered exhaust+ engine - covered driveline, wheel)	60,4
tyre, driveline, ... (=fully covered)	68,6

5.8. Yamaha T-Max

Yamaha T-Max Overall Results UNECE-R 41.04. / Annex 3

Table 68: Measurement result Yamaha T-Max UNECE-R 41.04. / Annex 3 Original Setup without noise damping measures

T-Max ANNEX 3								
Lurban	Lwot,rep	Lcrs,rep	a urban [m/s²]	a wot,ref [m/s²]	kp	k	Calc. Type	PMR
74,9	81	71,4	1,47	2,76	0,63	0	R41 rev3	119.5

Table 69: Measurement result Yamaha T-Max UNECE-R 41.04. / Annex 3 (Original Setup without noise damping measures)

T-Max ANNEX 3				
	L [dB(A)]	Lmax L [dB(A)]	Lmax R [dB(A)]	a [m/s²]
Acceleration WOT	81	79,2	81	4,02
Constant 50 km/h	71,4	70,3	71,4	0,12

Yamaha T-Max Reference Measurements Vehicle Speed & Acceleration

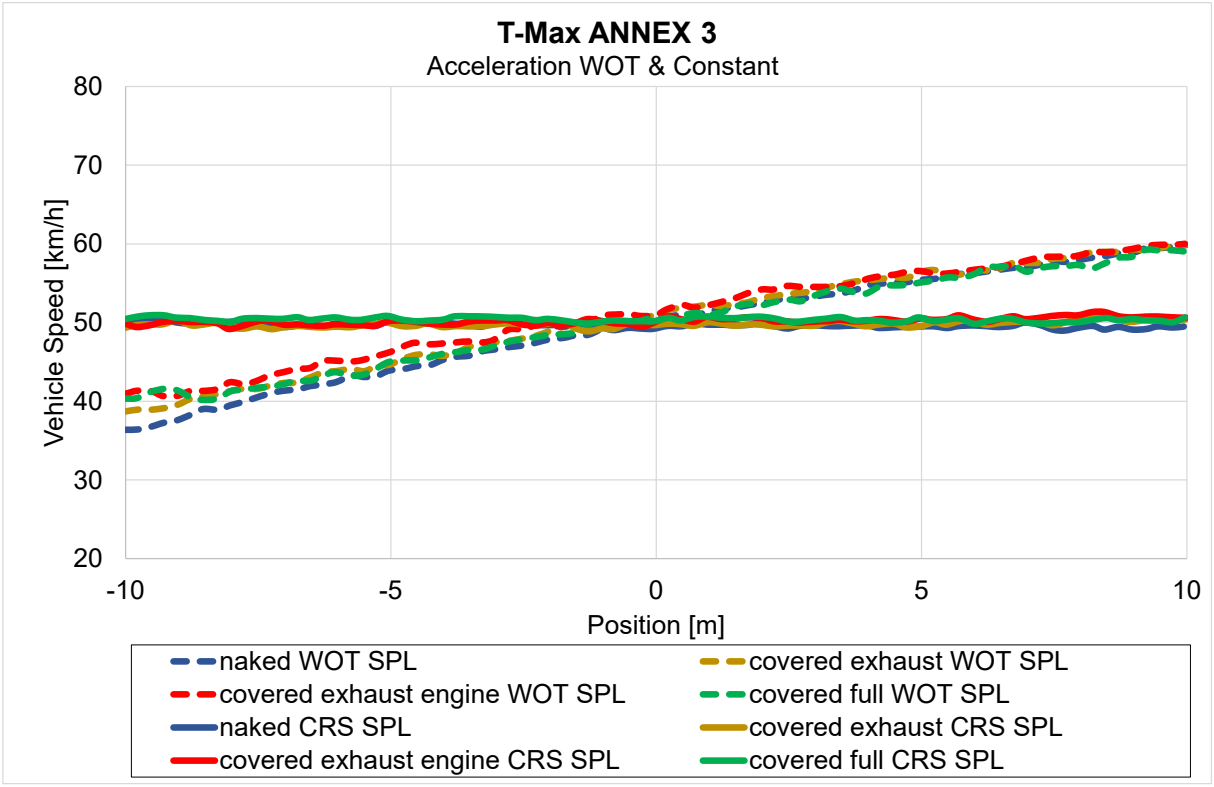

Figure 89: Yamaha T-Max ANNEX Vehicle Speed for Acceleration WOT & Constant Speed / Comparison noise damping variants

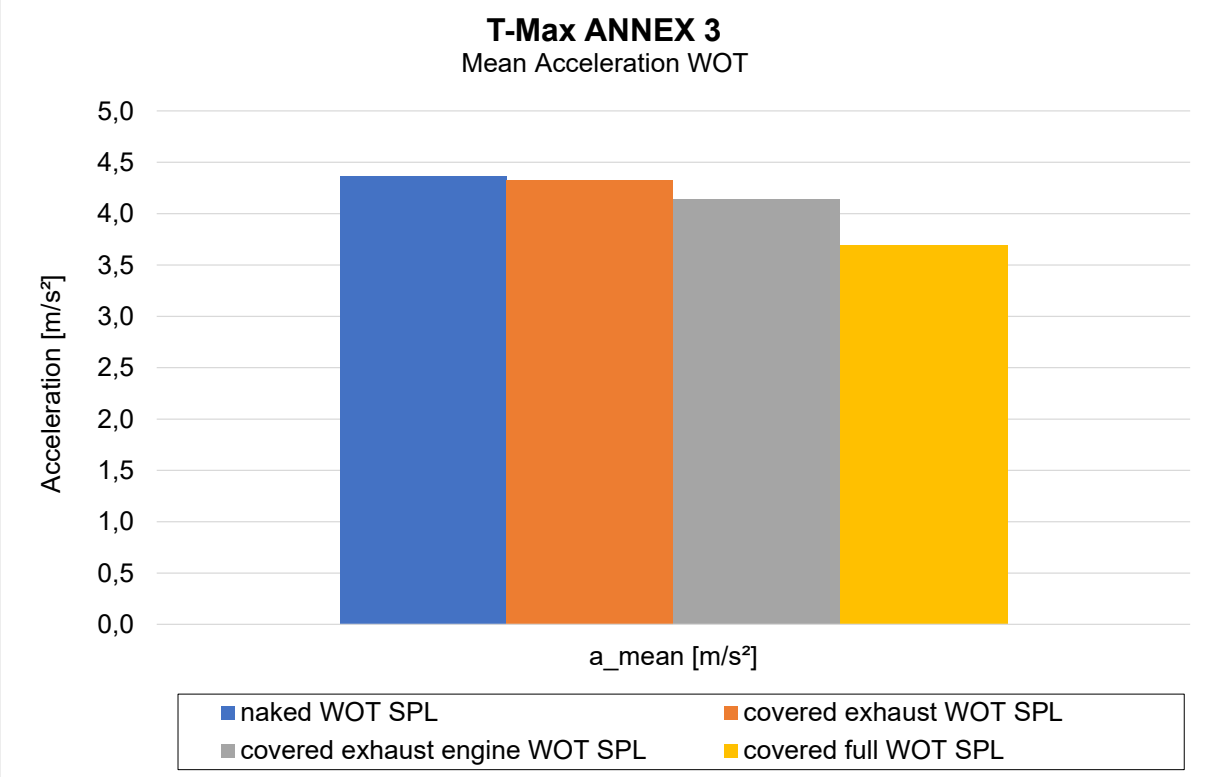

Figure 90: Yamaha T-Max ANNEX Acceleration WOT / Comparison noise damping variants

Yamaha T-Max Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Acceleration WOT to 50km/h

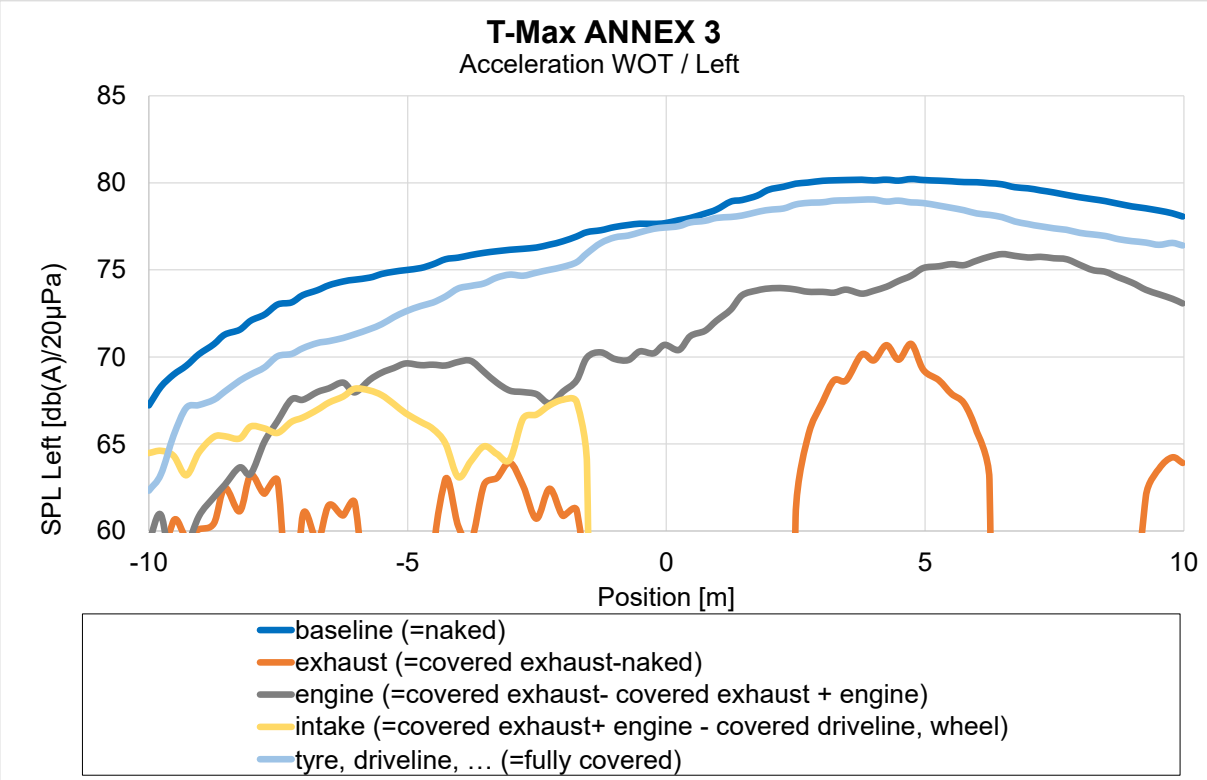

Figure 91: Yamaha T-Max Noise Contribution of Components Acceleration WOT left vehicle side

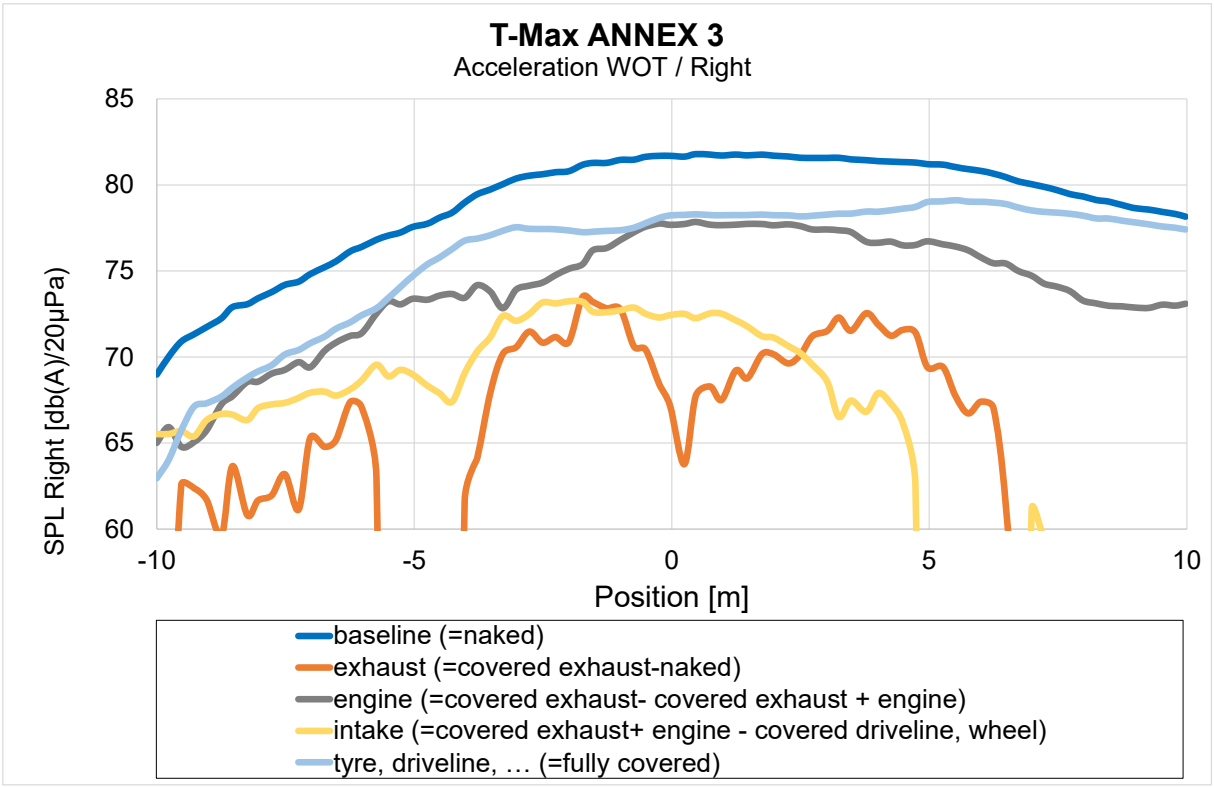

Figure 92: Yamaha T-Max Noise Contribution of Components Acceleration WOT right vehicle side

Table 70: Yamaha T-Max: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT left vehicle side

T-Max ANNEX 3 / Acceleration WOT	SPL Left [db(A)/20µPa] max
baseline (=naked)	80,2
exhaust (=covered exhaust-naked)	70,8
engine (=covered exhaust- covered exhaust + engine)	75,9
intake (=covered exhaust+ engine - covered driveline, wheel)	68,2
tyre, driveline, … (=fully covered)	79,0

Table 71: Yamaha T-Max: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Acceleration WOT right vehicle side

T-Max ANNEX 3 / Acceleration WOT	SPL Right [db(A)/20µPa] max
baseline (=naked)	81,8
exhaust (=covered exhaust-naked)	73,5
engine (=covered exhaust- covered exhaust + engine)	77,8
intake (=covered exhaust+ engine - covered driveline, wheel)	73,2
tyre, driveline, … (=fully covered)	79,1

Yamaha T-Max Contribution of Components to Overall Noise at Measurements UNECE-R 41.04. / Annex 3 Constant Speed 50km/h

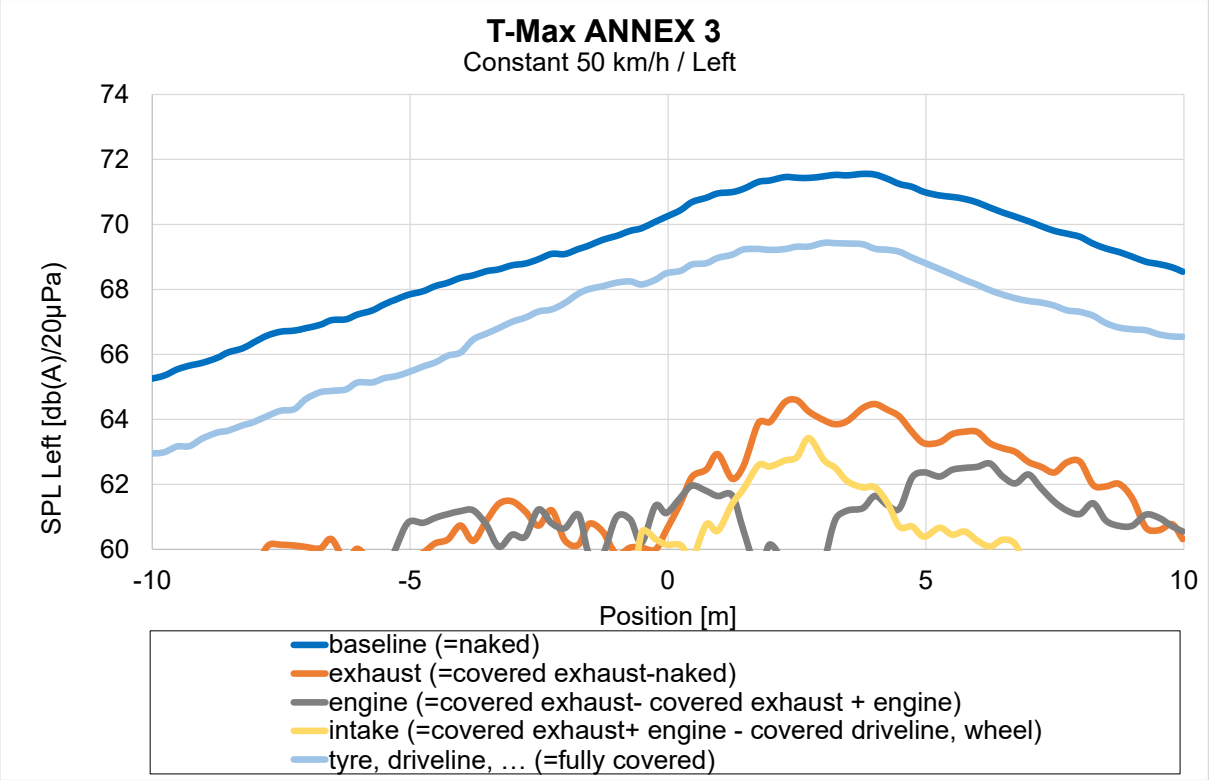

Figure 93: Yamaha T-Max Noise Contribution of Components Constant Speed 40 km/h left vehicle side

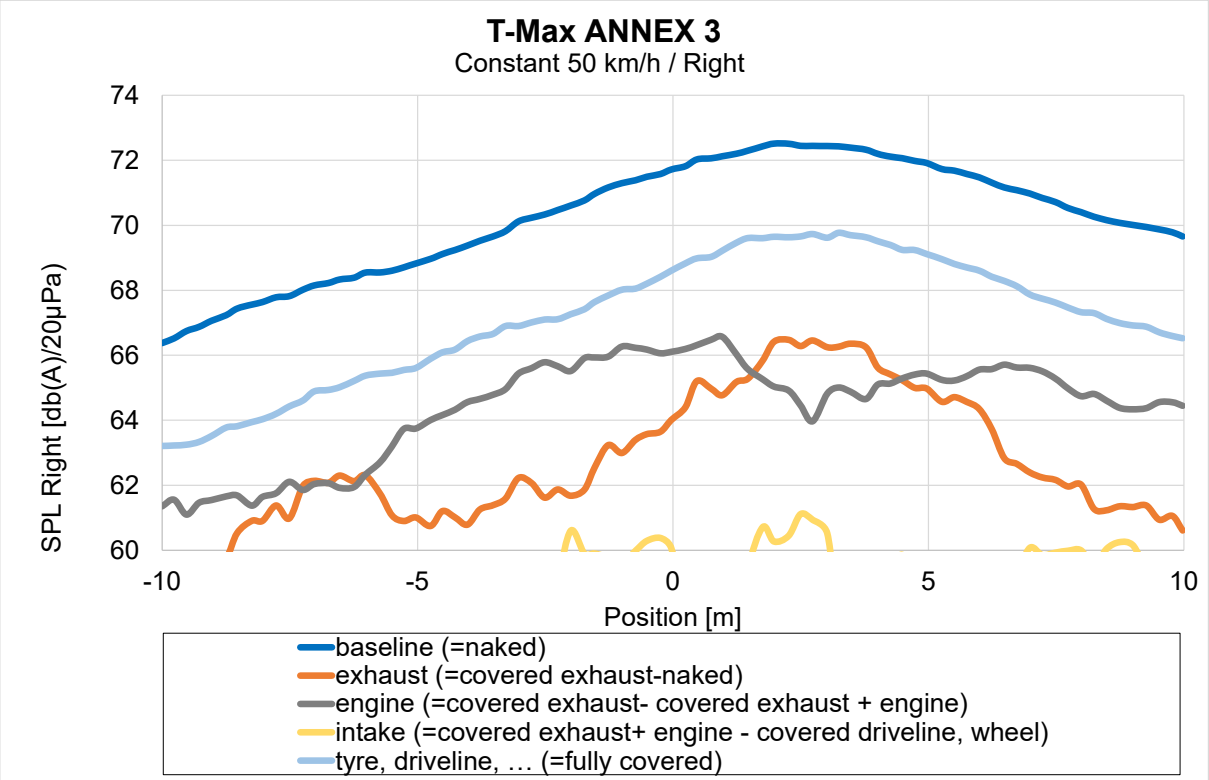

Figure 94: Yamaha T-Max Noise Contribution of Components Constant Speed 40 km/h right vehicle side

Table 72: Yamaha T-Max: UNECE-R 41.04. / Annex 3: Noise Contribution of Constant Speed 40km/h left vehicle side

T-Max ANNEX 3 / Constant 50 km/h	SPL Left [db(A)/20µPa] max
baseline (=naked)	71,6
exhaust (=covered exhaust-naked)	64,6
engine (=covered exhaust- covered exhaust + engine)	62,6
intake (=covered exhaust+ engine - covered driveline, wheel)	63,4
tyre, driveline, … (=fully covered)	69,4

Table 73: Yamaha T-Max: UNECE-R 41.04. / Annex 3: Noise Contribution of Components Constant Speed 40km/h right vehicle side

T-Max ANNEX 3 / Constant 50 km/h	SPL Right [db(A)/20µPa] max
baseline (=naked)	72,5
exhaust (=covered exhaust-naked)	66,5
engine (=covered exhaust- covered exhaust + engine)	66,6
intake (=covered exhaust+ engine - covered driveline, wheel)	61,1
tyre, driveline, … (=fully covered)	69,8

6. Findings & Recommendations

- Indicators for comparable runs

  When applying additional damping and encapsulation material to the vehicle, additional load has to be accelerated. This load exceeds the legislative tolerance clearly, leading to a considerable influence on the acceleration behavior (see Figure 42). This will affect the vehicles operation points during measurement and also the noise emission.

  Additionally, the calculation of the L_{urban} is based on several parameters like power-to-mass-ratio PMR or the actual reached acceleration. As both values will differ for different damping measures, the calculation of L_{urban} is influenced.

  Therefore, indicators for comparable measurement runs have to be defined and a decision whether to use the “original setup” parameters or the actual parameters for calculating comparable overall noise level values has to be made.

7. List of figures

8. References

[1] ECE/324/Rev.1/Add.40/Rev.2 ANNEX 3