#5 ASEP IWG
Report of measurement

2017.11

JASIC

Contents

- Result of measurement
- Findings during measurement and analysis
- Summary

Measurements were performed in order to create following Sound Model

1 The "Prediction Model" for the **Tyre Rolling Sound**

$$L_{TR,NL} = slope_{TR} * LOG_{10}(v_{test} / 50) + L_{REF,TR}$$

2 The "Prediction Model" for the Power Train (No Load)

$$L_{pt,NL} = slope_{PT,NL} * LOG_{10}(n_{test} + n_{shift}) / (n_{wot,ref} + n_{shift})) + L_{REF,NL}$$

3 **The Dynamic Model**

$$L_{PT,FL} = \mathbf{slope} * LOG_{10}(n_{test} + \mathbf{n_{shift}}) / (n_{wot,ref} + \mathbf{n_{shift}})) + \mathbf{L_{REF, FL}} + \Delta \mathbf{L_{partial}}$$

Overview of tested conditions

Following measurements were performed according to Test Program (ASEP-04-05 Rev.1)
(for blanks, measurements were not made)

Test vehicle			Vehicle-A (5MT)		Vehicle-B (5MT)		Vehicle-C (5MT)	
Spec.	Category		M1		N1		N1	
	Displacement		1240 cc		658 cc		658 cc	
	Max. Power		66 kW / 5600 rpm		37 kW / 5700 rpm		35 kW / 5500 rpm	
	mro		1145 kg		845 kg		845 kg	
	PMR		65.0		43.8		41.4	
	Tyre size		165/70R14		145R12-6PR LT		145R12-6PR LT	
R51-03 Annex 3			3rd, 50km/h		4th, 50 km/h			
Acceleration	1st	FL	**exceeding the rated engine speed, S**		**No valid data by exceeding the rated engine speed, S**		**Vehicle-C could not be measured.**	
		PL						
	2nd	FL	9-66 km/h	2.0-2.2 m/s²				
		PL	9-65 km/h	0.5-1.6 m/s²				
	3rd	FL	19-94 km/h	1.2-1.4 m/s²	7-55 km/h	1.6-1.9 m/s²		
		PL	30-91 km/h	0.4-0.9 m/s²	6-55 km/h	0.5-1.5 m/s²		
	4th	FL	22-103 km/h	0.8-0.9 m/s²	25-82 km/h	0.9-1.1 m/s²		
		PL	40-101 km/h	0.4-0.5 m/s²	27-81 km/h	0.4-0.9 m/s²		
	5th	FL	25-101 km/h	0.5-0.6 m/s²	27-100 km/h	0.4-0.8 m/s²		
		PL	25-31 km/h	0.5 m/s²	28-71 km/h	0.4-0.6 m/s²		
Tyre rolling	N	―	20-115 km/h		21-104 km/h		19-93 km/h	
Stationary	N	NL	850-5600 rpm		800-5700 rpm		900-5500 rpm	

*FL: Full load (wot) , PL: Partial load, NL: No load

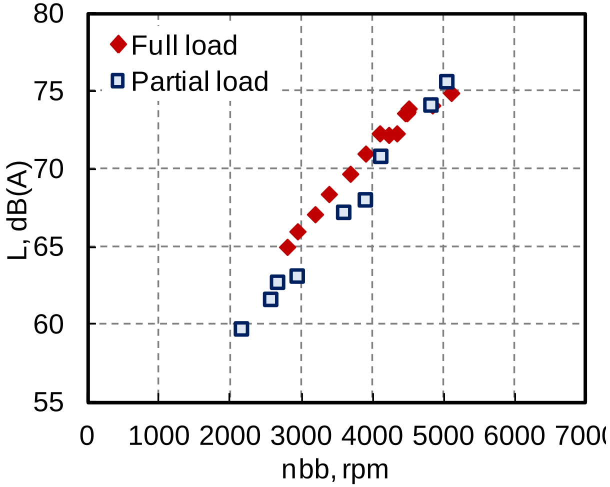
Example of test results

Vehicle-A, Acceleration sound

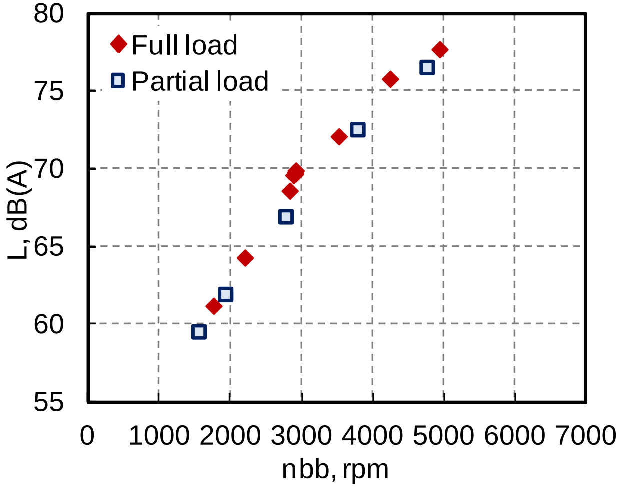
1st

Test was not performed in 1st gear because the engine speed exceed the rated speed, S.

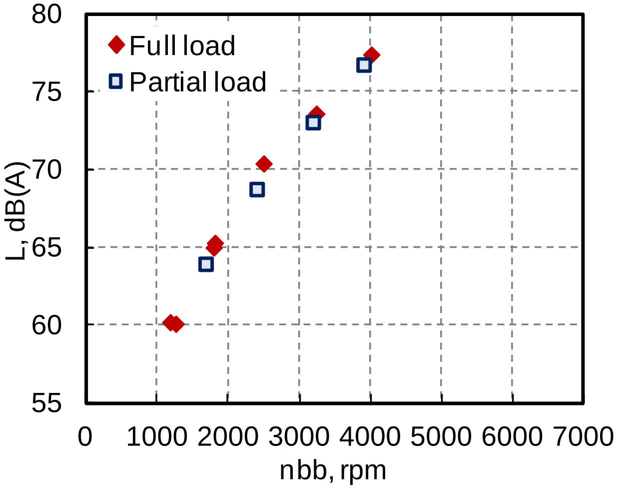
2nd



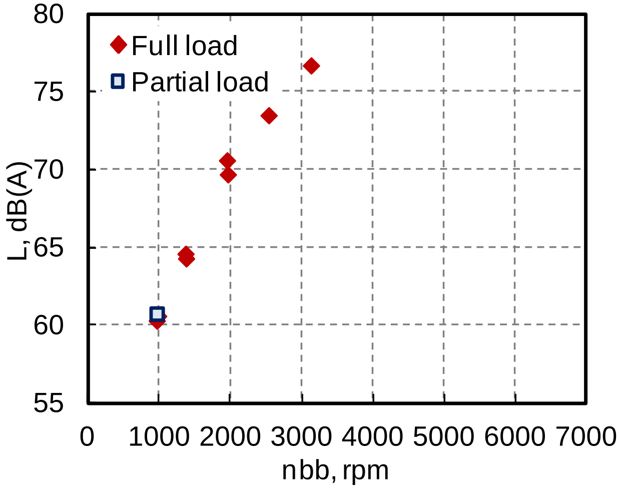
3rd



4th



5th



Example of test results

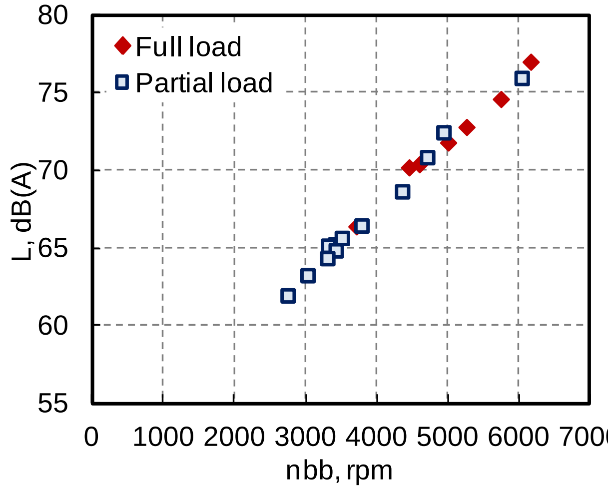
Vehicle-B, Acceleration

1st

2nd

Test was not performed in 1st and 2nd gear because the engine speed exceed the rated speed, S.

3rd



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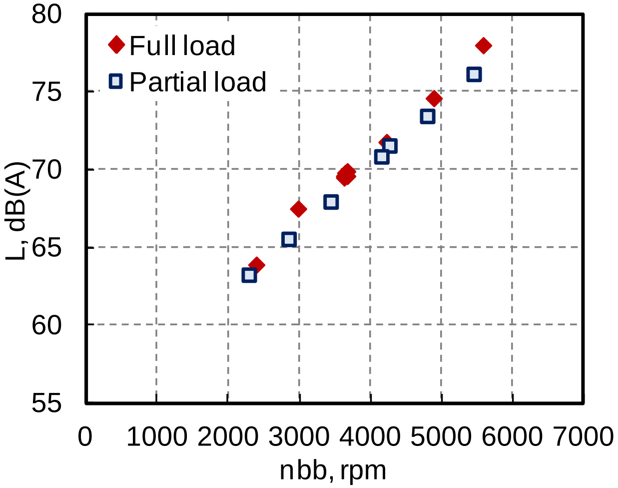

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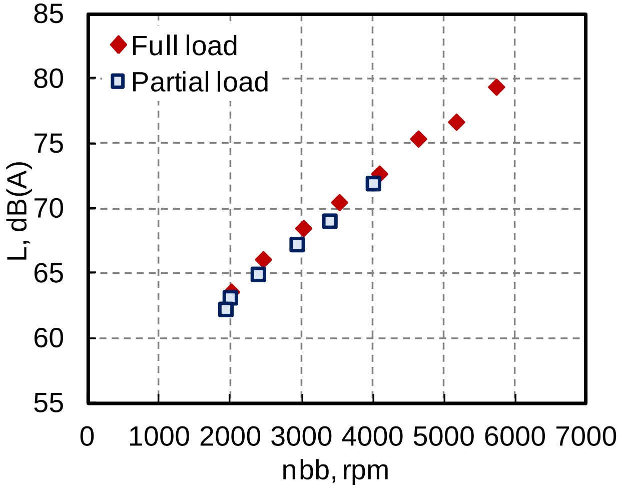
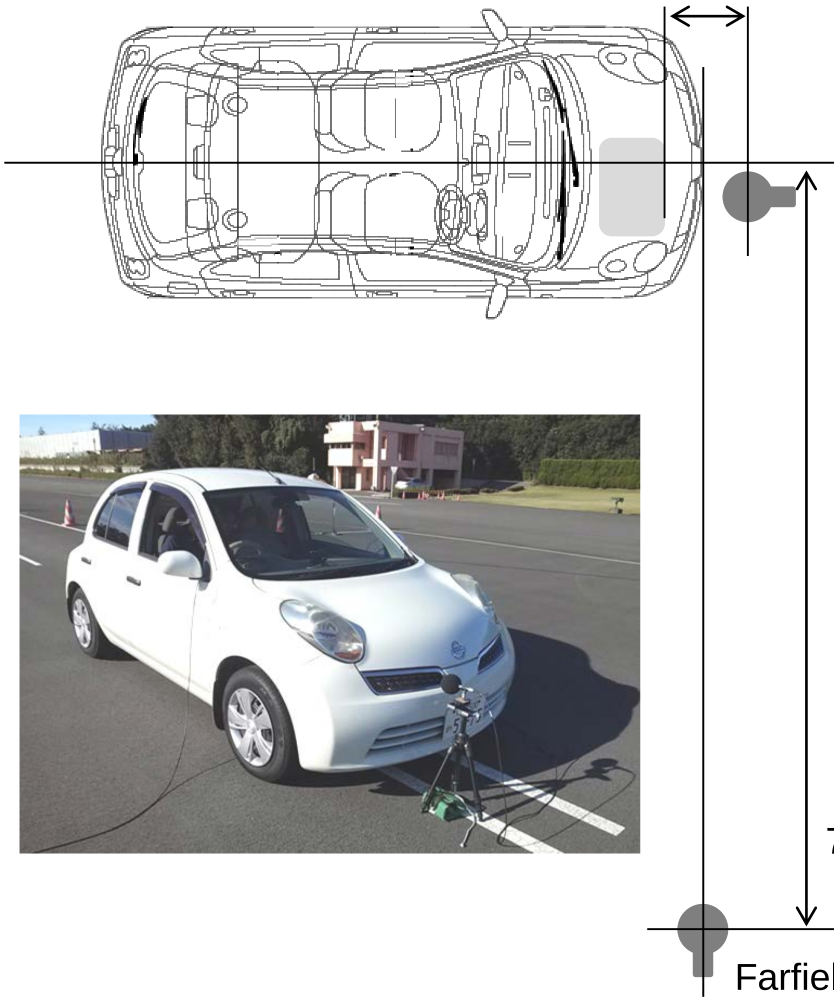


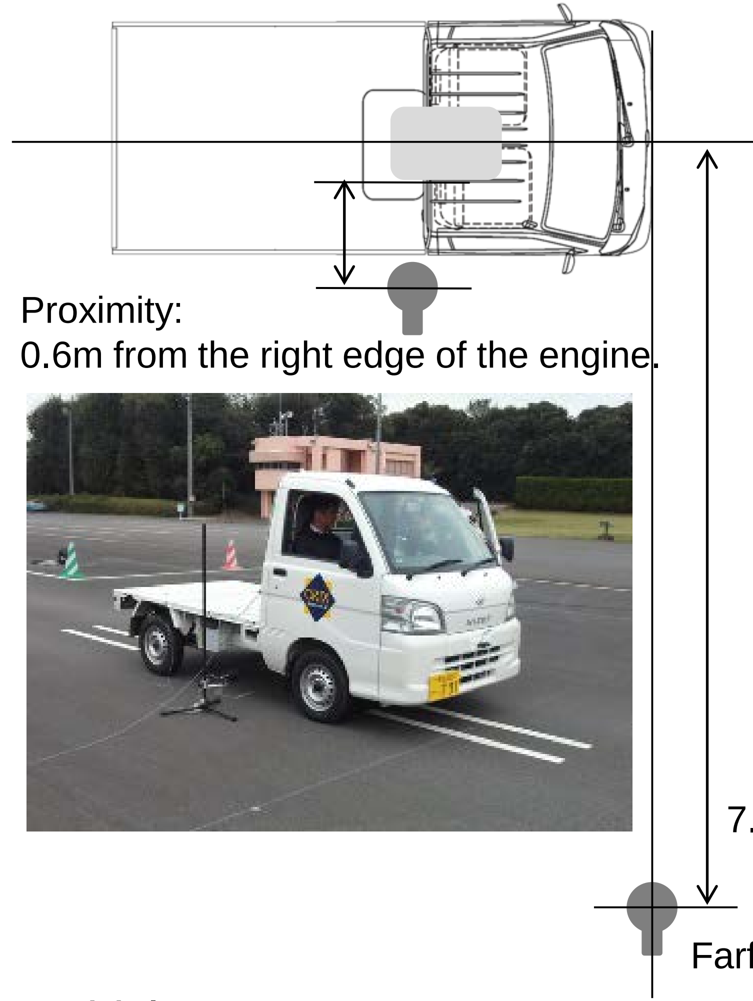
Stationary

Vehicle-A

Proximity: 0.5m from the front edge of the engine.



Vehicle-B



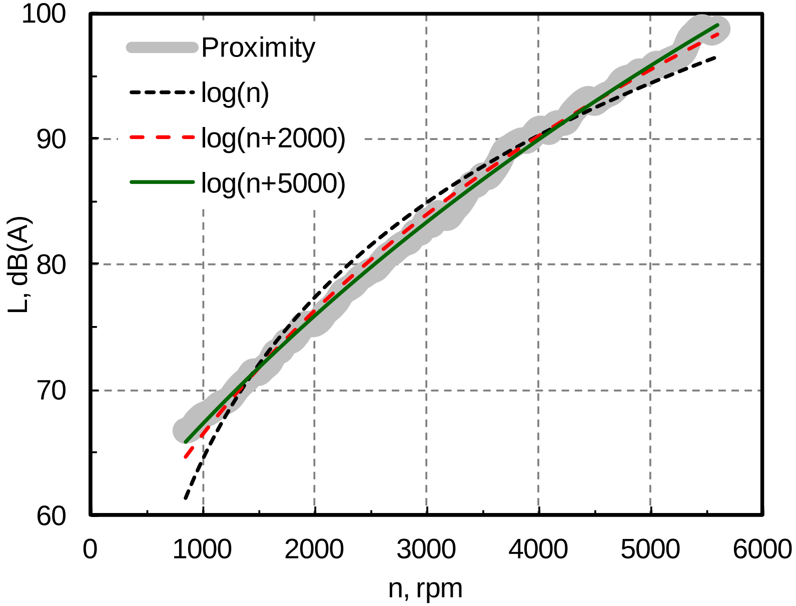
Vehicle-C

Approximately same as vehicle-B, Proximity:
1.0m from the right edge of the engine

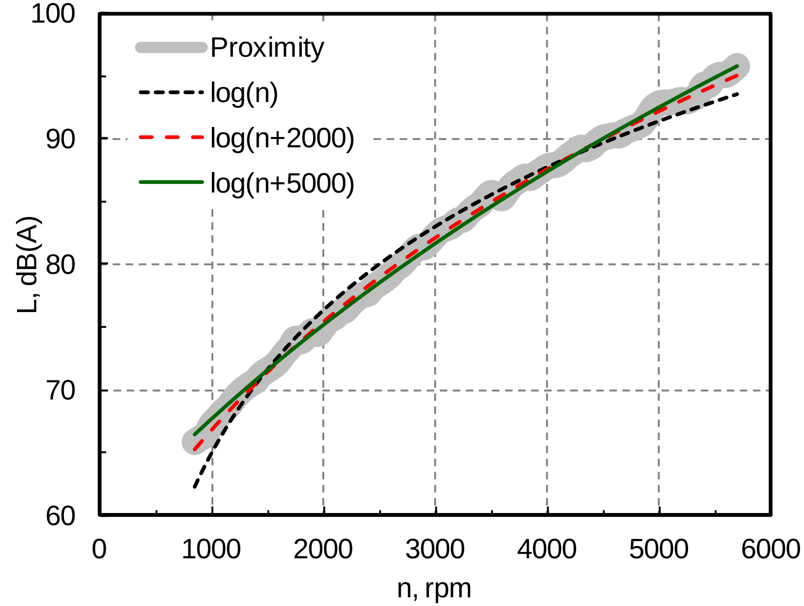
Example of test results

Stationary sound

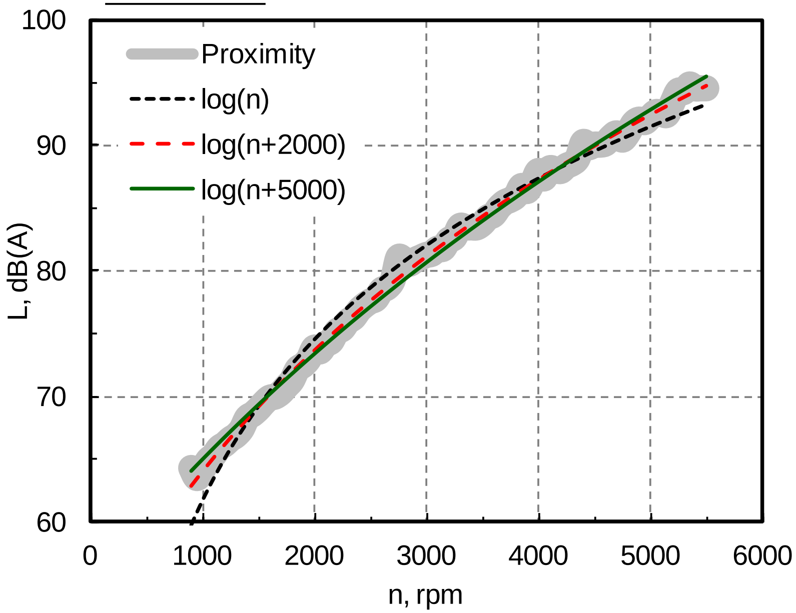
Vehicle-A



Vehicle-B



Vehicle-C



$$L_{PT} = A_0 + A_1 \log \frac{n + n_{shift}}{n_{wot,ref} + n_{shift}}$$

n_{shift}		0	2000	5000
A_1 @proximity	Vehicle-A	43.0	79.0	128.8
	Vehicle B	37.8	68.9	111.8
	Vehicle-C	42.6	77.4	125.8
A_0 @farfield	Vehicle-A	63.0	61.9	61.4
	Vehicle B	63.6	63.1	62.8
	Vehicle-C			

n_{shift}=5000rpm seems to be good for the measurement.

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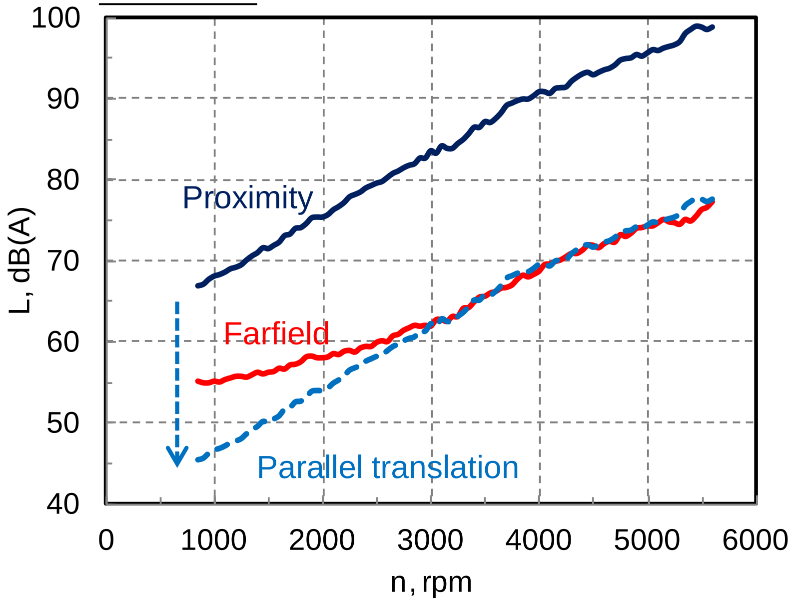
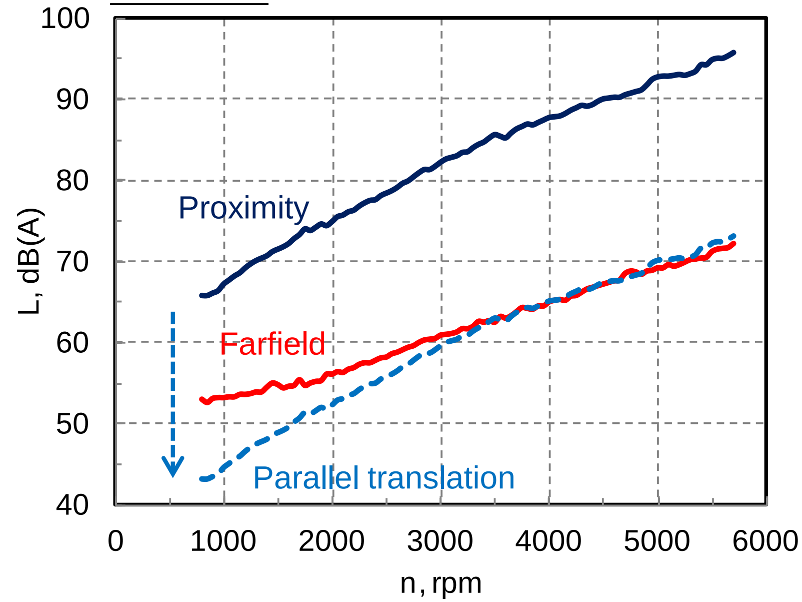
Issue 1: Background Noise at measurement

Stationary sound

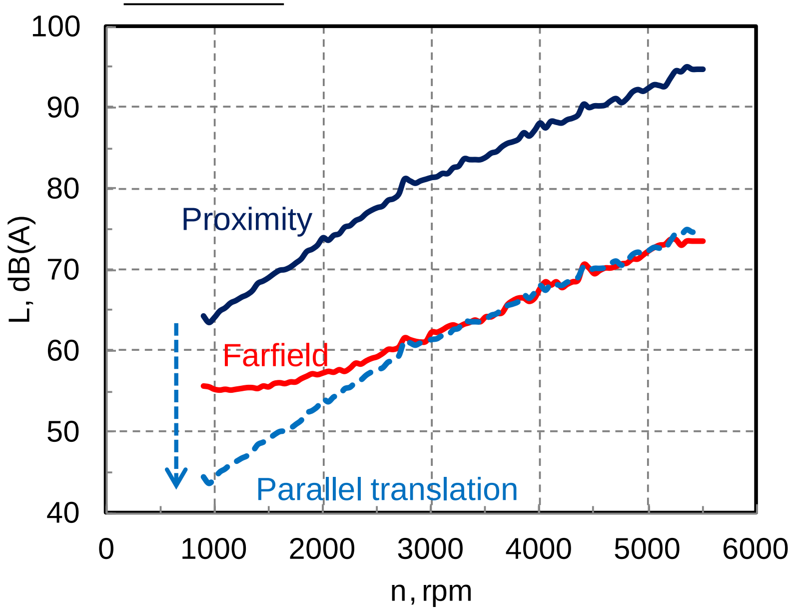
Vehicle-A



Vehicle-B



Vehicle-C



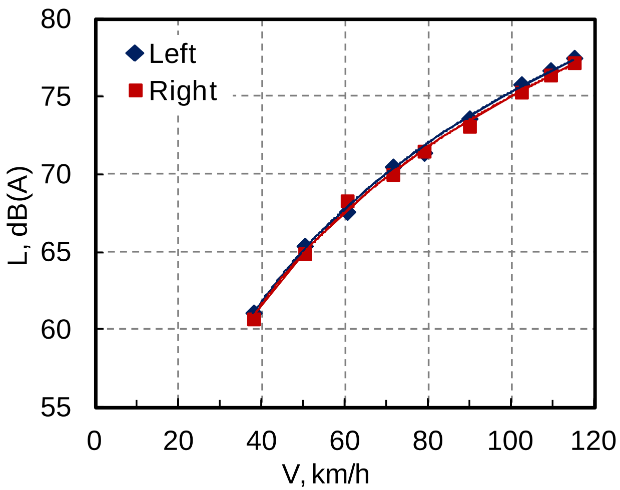
(Issue 1)
It was difficult to measure the sound below 3000rpm at a position of 7.5m (Farfield), because the background noise was 50 to 55dB(A).
In order to measure at full range of engine speed, the background noise need to be approx. 35dB(A)

↓

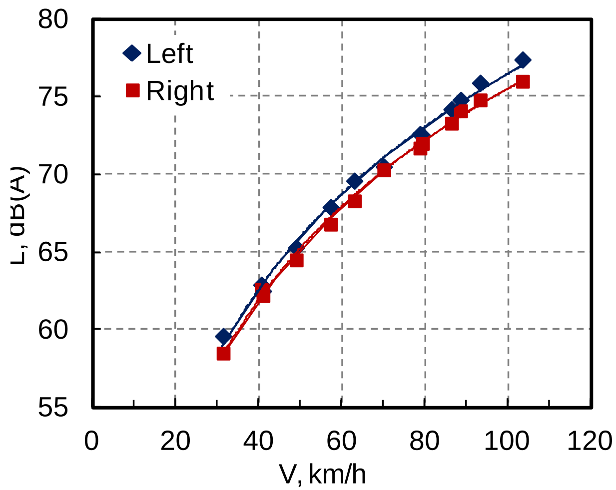
(Idea)
Fill in the gap by the result of the proximity measurement .

Tyre rolling sound

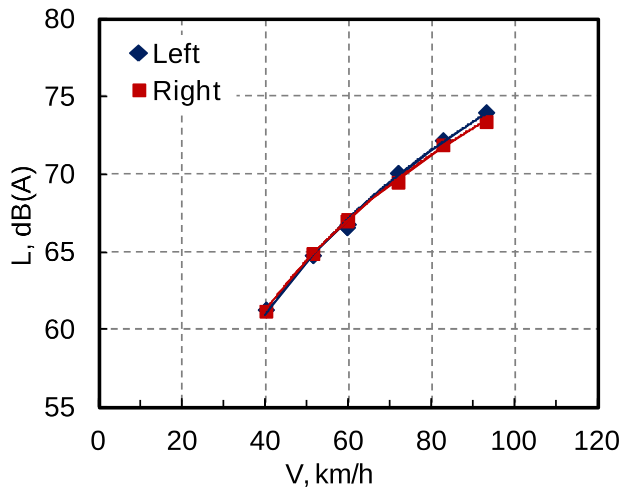
Vehicle-A



Vehicle-B



Vehicle-C



$$L_T = B_0 + B_1 \log \frac{V}{V_{50}}$$

	Left	Right
B_0	65.1	64.9
B_1	34.0	33.7

	Left	Right
B_0	65.9	65.2
B_1	34.9	34.2

	Left	Right
B_0	64.4	64.4
B_1	35.3	33.4

(Issue 1)
It was difficult to measure the sound below 30 km/h because the background noise were 50 to 55dB(A)
↓
(Idea)
If B1 is appropriate value, extrapolation of regression results of 40 km / h or more.

Issue 2 $L_{REF,TR}$ の決定方法

① The "Prediction Model" for the **Tyre Rolling Sound**

$$L_{TR,NL} = slope_{TR} * LOG_{10}(v_{test} / 50) + L_{REF,TR}$$

★ $L_{REF,TR} = 10 * LOG_{10}(10^{(x\% * L_{crs,rep}/10)})$

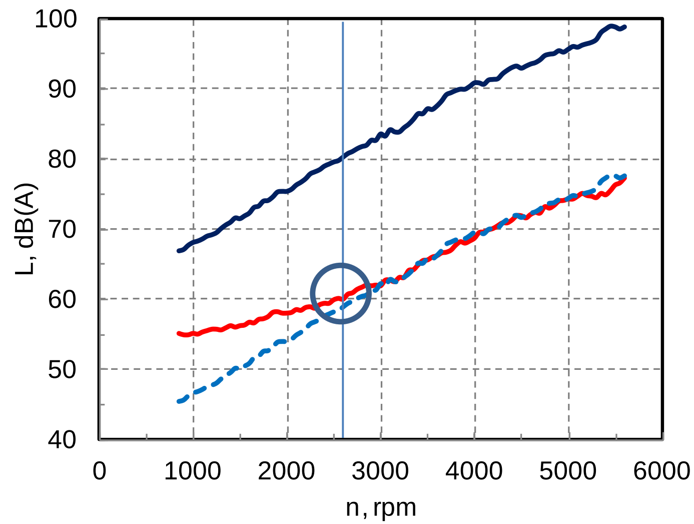
[* $\ominus$: 騒音レベルのエネルギ計算]

$L_{REF,TR} = L_{crs,rep}$ $\ominus$ No load power train sound at 50km/h

$L_{crs,rep}$ = 66.4 dB

$L_{PT,NL}$ = 59.3 dB

$$L_{REF,TR} = L_{crs,rep} \ominus L_{PT,NL}$$
$$= 66.4 \ominus 59.3$$
$$= 65.5 \text{ dB } (x = 81.3\%)$$



$L_{pt, NL}$=59.3dB @2620rpm

Or

$L_{REF,TR}$ = tire noise at coasting at 50km/h

$L_{REF,TR}$ = Tire rolling noise at 50km/h）
= 65.1 dB (x=74.1%)

Issue 3 $L_{REF,NL}$ の決定方法

② The "Prediction Model" for the Power Train (No Load)

$$L_{pt,NL} = slope_{PT,NL} * LOG_{10}(n_{test} + n_{shift}) / (n_{wot,ref} + n_{shift})) + L_{REF,NL}$$

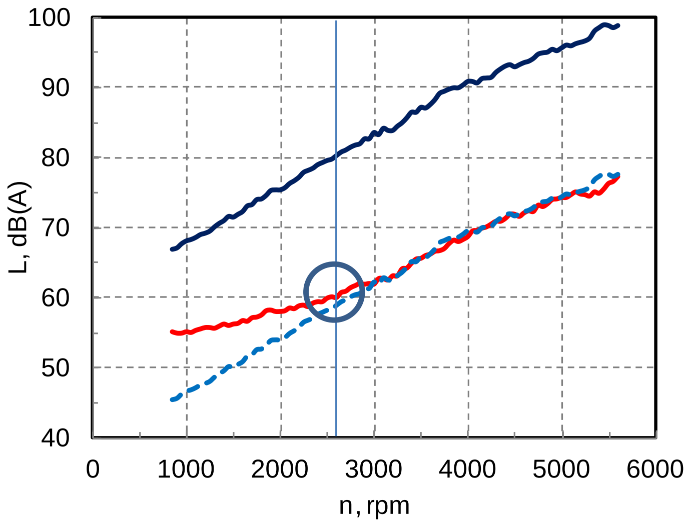
$L_{REF,NL}$ = No load power train sound at 50km/h

59.3 dB from the data
19% of $L_{crs,rep}$ (66.4dB)

Or

$$L_{REF,NL} = 10 * LOG_{10}(10^{((100\%-x\%)*L_{crs,rep}/10)})$$

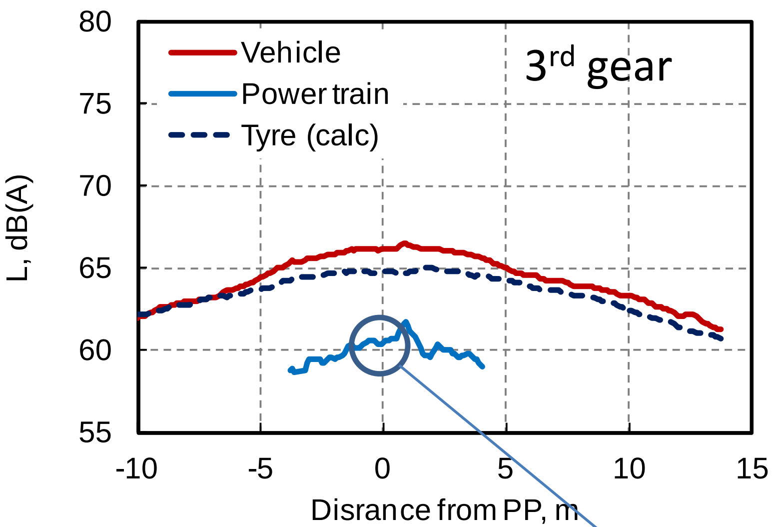
19% $L_{crs,rep}$ x= 81%
or 26% $L_{crs,rep}$ x=74%

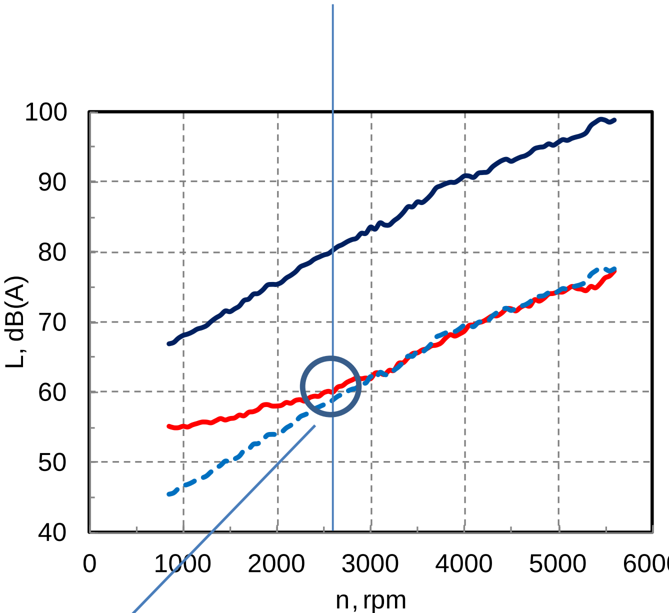


$L_{pt,NL}$=59.3dB @2620rpm

Confirmation of the influence for gas flow noise (power train noise with load)
"In addition, a small correction for the gas flow is necessary." According to OICA presentation material in ASEP#4

Increment of the Power Train Noise Traction at constant speed
＝Power Train Noise at constant speed ⊖ Power Train Noise at no loaded condition





V=50km/h
Npp=2620rpm
Lpp=60.5dB

L= 59.3dB @2620rpm

54.3dB (Calculated at 60.5dB/59.3dB)
Lcrs,rep (66.4dB)の6%

Can this percentage applicable to lower gear and lower speed?

1 The "Prediction Model" for the Tyre Rolling Sound

$$L_{TR,NL} = slope_{TR} * LOG_{10}(v_{test} / 50) + L_{REF,TR}$$

★ $L_{REF,TR} = 10 * LOG_{10}(10^{(x\% * L_{crs,rep}/10)})$

$L_{REF,TR} = L_{crs,rep}$ ⊖ No load power train sound at 50km/h (x= 81.3%)

Or

$L_{REF,TR} =$ tire noise at coasting at 50km/h (x=74.1%)

2

$$L_{pt,NL} = slope_{PT,NL} * LOG_{10}(n_{test} + n_{shift}) / (n_{wot,ref} + n_{shift})) + L_{REF,NL}$$

$L_{REF,NL} =$ No load power train sound at 50km/h 19% of $L_{crs,rep}$

Or

$L_{REF,NL} = 10 * LOG_{10}(10^{((100\%-x\%)*L_{crs,rep}/10)})$

19% x= 81%

or 26% x=74%

Without consideration of gas flow noise

Issue 4: Procedure to obtain the Power Unit Related Noise LPT

③ The Dynamic Model

(How to subtract the tyre sound from the vehicle sound)

$$L_{PT,FL} = \textbf{slope} * LOG_{10}(\, n_{test} + \mathbf{n_{shift}}) / (n_{wot,ref} + \mathbf{n_{shift}})) + \mathbf{L_{REF,\,FL}} + \mathbf{\Delta L_{partial}}$$

Option1

$$L_{PT,FL} = L_{wot,test} \ominus L_{TR,NL} \ominus L_{pt,NL}$$

$L_{TR,NL}$ 、$L_{pt,NL}$ need to be obtained first.

Option2

$L_{PT,FL} = L_{wot,test} \ominus L_{crs,test} \oplus$ ncrease of Power Train Sound Traction at constant speed

Measurement of Lcrs is required but for LTR,NL, LPT, NL.
Use the fixed value (x% of Lcrs) for Increase of Power Train Sound Traction at constant speed, or omit this because the effect is small.

$$L_{wot} \ominus L_{crs} = L_{PT,NL} \oplus L_{PT,FL} \oplus L_{tyre} \ominus L_{tyre} \ominus L_{PT,NL} \ominus L_{PT,crs\text{-}L}$$

Summary

Followings need to be determined for the future analysis

Check points for the Measurement

Issue 1: Background Noise at Measurement

Fill in the Gap by the result of the proximity measurement for PT-NL measurement.
Accept extrapolation of the data measured at lower speed for tyre sound measurement.

Procedure for the analysis (Is Japanese way acceptable?)

Issue 2: Determination of LREF, TR

Issue 3: Determination of LREF, NL

Issue 4: Procedure to obtain the Power Unit Related Noise LPT