Drive-by noise test

Measurement Uncertainty
(Application to Vehicle Categories M2 with GVW>3500 kg, M3, N2, N3)

STATUS REPORT

Referring to ISO 362-1/R51.03
Prepared for UNECE GRBP IWG-MU

Volvo, Scania, UD Trucks, Hino, MAN, Daimler, Renault, Isuzu, DAF
2021-05-25

Justification of the main impact quantities.

<u>Justification by different approaches:</u>

1. by **measurement** (or simulation) results from specific experiments, e.g. investigations on power train noise at indoor test bench
2. by classic **statistical methods** e.g. parameter studies and correlation analysis (ACEA Tyre study)
3. by **theoretical** derivations based on physical relations e.g. distance law (deviation from centered driving)

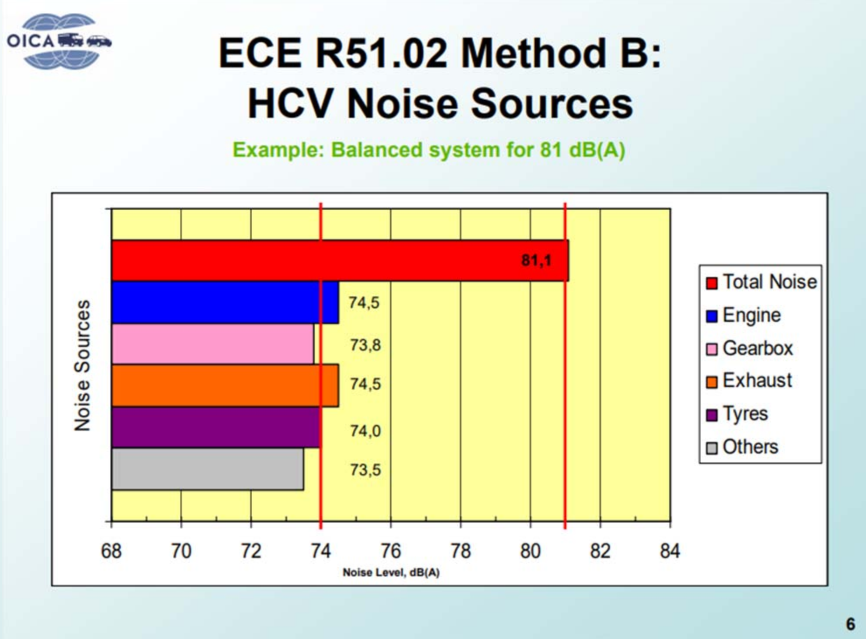
Definitions of reproducibility

- ISO 362-1, Scope: *"… The specification are to reproduce the level of noise generated by the principal noise sources during normal driving in urban traffic, ... The method is designed to meet the requirements of simplicity as far as they are consistent with reproducibility of results under the operating conditions of the vehicle."*
- ISO 362-1, Clause 8.5 definitions of
  - run-to-run – *variations expected within the same test laboratory and with slight variations in ambient conditions found within a single test series,* ***(The average of 4 passages.)***
  - day-to-day – *variations expected within the same test laboratory but with variation in ambient conditions and equipment properties that can normally be* *<u>expected during the year</u>,*
  - site-to-site – *variations between test laboratories where, apart from ambient conditions, equipment, staff, and road surface conditions are also different*.
- Definition of vehicle-to-vehicle
  - New-to-new …
  - New-to-old respectively …

Assumed source distribution

Reference: GRB-51-inf20e

ICE: With balance between the sources, then one of the sources affect the total by 1/5.



EV vehicle
Can be elaborated and added at later stage by HCV members of ISO SC1/TC43/WG42

Justification of the main impact quantities.

situation	Input Quantity {Uncertainty of vehicle sound emission}	For indoor	Type B: Deviations of the meas. result (peak-peak) Lwot	probability distribution	variance	standard deviation	contribution [%]	Type B Combined standard uncertainty
Run to run	1) Micro climate wind effect – head wind and tail wind		0	gaussian	0,000	0,000	0,0%	0,3
	2) Deviation from centered driving		0,5	rectangular	0,021	0,144	3,8%	
	3) Speed at BB' – Target vehicle speed (+/-5 km/h), (target engine speed (+/-2%)	x	0,4	rectangular	0,013	0,115	2,4%	
	4) Varying background noise	x	0,1	gaussian	0,001	0,025	0,1%	
	5) Warming up routines between runs – operating temperature of engine and tyres (WOT) ==> See ISO 362-1 NOTE	x	0,8	rectangular	0,053	0,231	9,7%	
Day to day	6) Ambient temperature influence on sound transmission in air (variability in impedance)		0,6	rectangular	0,030	0,173	5,5%	0,5
	7) Ambient barometric pressure influence on sound transmission in air	x	0,9	rectangular	0,068	0,260	12,3%	
	8) Ambient humidity influence on sound transmission in air		0,1	rectangular	0,001	0,029	0,2%	
	9) Ambient air temperature influence on engine power (based on R85)		1,0	rectangular	0,083	0,289	15,2%	
	10) Ambient air temperature effect on ICE vehicles due to tyre noise (5-40°C)	x	0,4	rectangular	0,013	0,115	2,4%	
	11) Barometric pressure effect on engine power (based on R85)	x	0,4	rectangular	0,013	0,115	2,4%	
Site to site	12) Altitude effect on combustion and sound propagation (Range: 1000 m) (95-105 kPa)	x	0,9	rectangular	0,068	0,260	12,3%	0,5
	13) Test Track Surface	x	1,3	gaussian	0,106	0,325	19,3%	
	14) Microphone Class 1 IEC 61672	x	1	gaussian	0,063	0,250	11,4%	
	15) Sound calibrator IEC 60942	x	0,5	gaussian	0,016	0,125	2,8%	
	16) Speed measuring equipment continuous at BB	x	0,1	gaussian	0,001	0,025	0,1%	
V to Vehicle	17) Tyre – generic dispersion (Normal, tread depth, inflation pressure, model etc) **		2,8	gaussian	0,490	0,700		0,7
	18) Test mass – variation as a consequence of the definition			gaussian	0,000	0,000		
	19) Battery state of charge for HEVs			gaussian	0,000	0,000		
COP	20) Production variability			gaussian	0,000	0,000		
Third party testing	21) Residual surface humidity			rectangular	0,000	0,000		
	22) Tyre (Traction, 3PMSF)			gaussian	0,000	0,000		

Expanded uncertainty of 0.6 dB for a coverage of 95%. See "*Statistical approach on the Measurement Uncertainty Run-to-Run.pdf*".

Variation of ambient condition representing a year cycle.

Vehicle tested at new location with new staff and new equipement.

Vehicle to vehicle aspects can be added at later stage by CV members of ISO SC1/TC43/WG42

* Red figures are preliminary and copied from M1 justifications. IWGMU-06-02 (OICA) 20200703_status_justification_quantity_values_mod.pptx

** Ref. Tan Li: 2018 - Tan Li - Influencing Parameters on Tire–Pavement Interaction Noise: Review, Experiments and Design Considerations

Run-to-run

A run is defined as complete test with 4 passages with short pause in-between during part of or one day, with minor variations in ambient conditions, but taking into account practical stochastic variations resulting from the test procedure, skill of the driver etc.

- Microclimate wind effect – head wind and tail wind
- Deviation from centered driving
- Speed at BB' – Varying vehicle speed (+/-5 km/h) and engine speed (+/-2%) due to start of acceleration (+/-0,5 m),
- Warming up procedure – Variation on operating temperature of **engine** and **tyres** (WOT) (See ISO 362-1 NOTE concerning warming up procedure)
- Varying background noise (judge if correction is needed - otherwise no issue - delta >15 dBA => MU<<0,1 dB) (delta >10 dB => MU<0,5 dB) (Compare also ISO 16254)

1) Micro climate wind – effect from head wind and tail wind

References:

1. Theoretical derivation from manufacturer's model

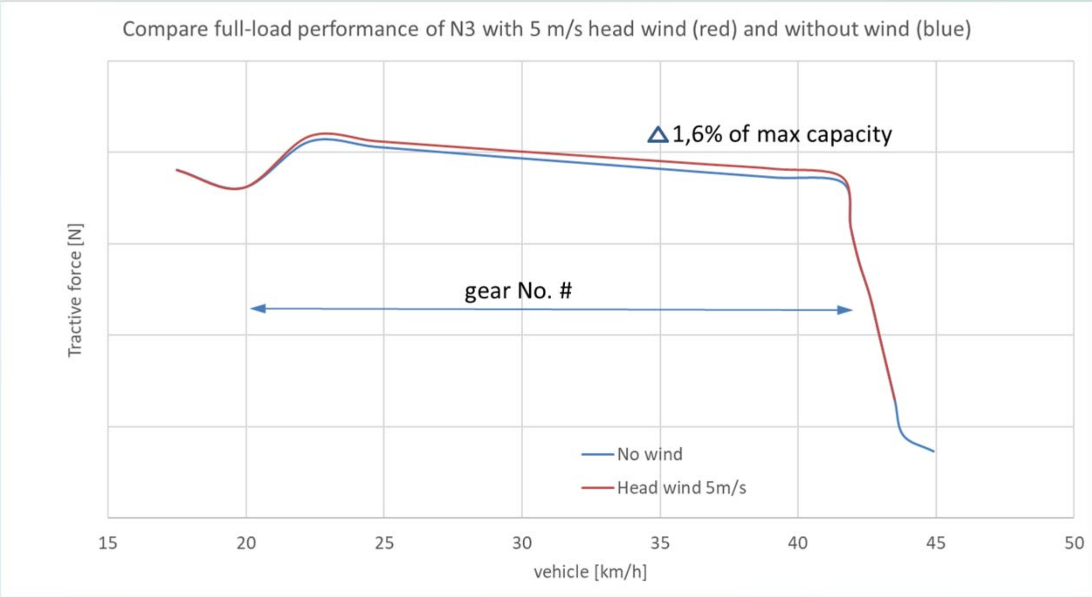
Observation:

The deviation in propulsion (tractive) force in case of head wind is less than 2% of the capacity of a normal N3.

Conclusion:

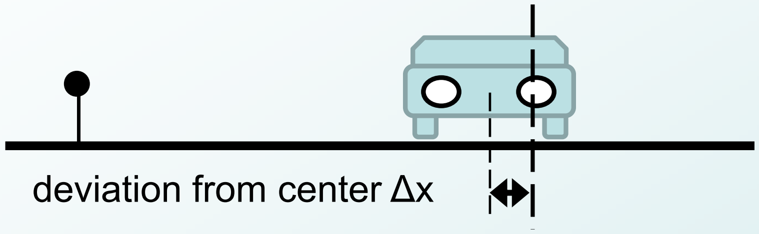
The effect of head/tail wind on the test cycle is neglectable.

Proposed uncertainty: N/A



2) Justification of the main impact quantities.

„ DRIVER#1: deviation from centered driving“ – justification by theoretical derivation



Invers square law:

$$\Delta SPL = \boldsymbol{a} * \frac{10}{3} * \log\left(\frac{7{,}5m + \boldsymbol{\Delta x}}{7{,}5m}\right)$$

with:

a	coefficient for dB/distance doubling
Δx	deviation from center

$$\Delta SPL = \mathbf{5} * \frac{10}{3} * \log\left(\frac{7{,}5m + \mathbf{0{,}5}m}{7{,}5m}\right) = \mathbf{0{,}5dB}$$

ΔSPL_{urban}:

0,5 dB

Assumption for the calculation: 5dB/distance doubling (monopole source under semi-free field conditions) and 0,5m for the deviation from center.

3) Speed at BB' – Tolerances: Target vehicle speed (+/-5 km/h), (target engine speed (+/-2%)

References:

1. Theoretical (See M1 justification)

Observation:

The target conditions at BB' shall be met with certain precision, determined by the rated speed and the available gear ratios (gearbox, rear axle, tyre dimension). The tolerance in starting position (driver dependent) allow for some variations of the achieved speed at BB', however with the same propulsion power/torque, and thus dispersion in SPL of tyres and powertrain.

Proposed uncertainty:

$SPL_{p\text{-}p}$ variability: 0,4 dB

Engine speed variation drives PowerTrain Noise variation (+/-2%)

$$SPL_{PRN}(n) = a + b * \log\left(\frac{n}{87\%\ S}\right)$$

with

a	SPL_{PRN} at 87%S, where S is the rated speed
b	coefficiency for speed

$$\Delta SPL_{PRN} = \mathbf{20} * \log\left(\frac{89}{85}\right) = \mathbf{0{,}4\ dB}$$

(80%contribution)

Tyre Road Noise variation **(+/-0,7 km/h or +/-2%)**

$$SPL_{TRN}(v) = a + b * \log\left(\frac{v}{35\ km/h}\right)$$

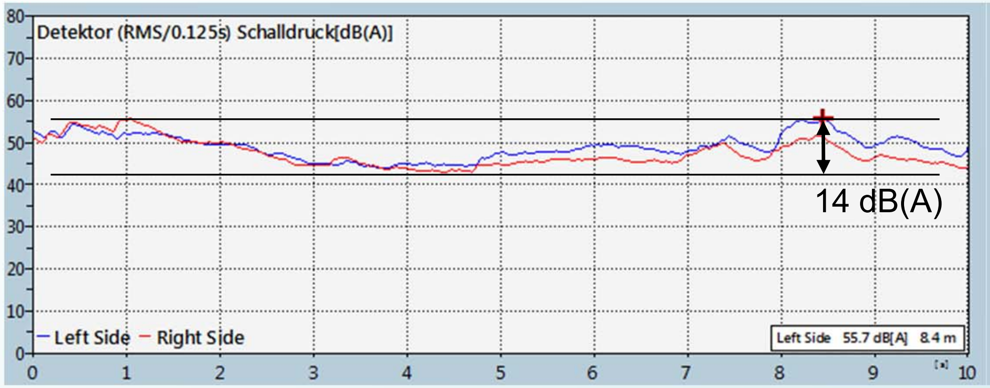
with

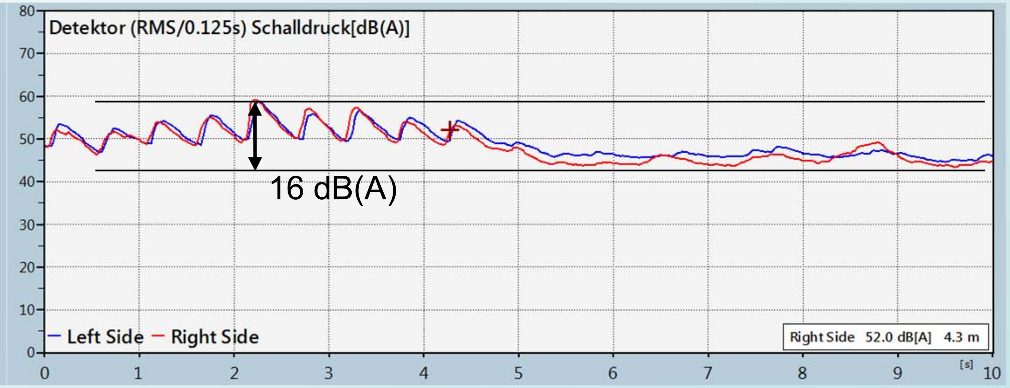
a	SPL_{TRN} at 35 km/h
b	coefficiency for speed dependency from R117

$$\Delta SPL_{TRN} = \mathbf{30} * \log\left(\frac{36}{34}\right) = \mathbf{0{,}5\ dB}\ \textbf{(20\% contribution)}$$

4) Justification of the main impact quantities.

„Varying background noise“ – justification by measurement





ΔSPL$_{urban}$: 0.0 – 0.4 dB

- Background shall be measured before and after a serious of measurements. During a measurement it is not possible to determine the background noise.
- While the background noise might be low during its measurement, transient broadband events with up to 60 dB(A) may occur.
- Such events are typical for test centers with multiple tracks and events, but hardly noticeable during pass-by measurements.
- These transient noises will be counted as vehicle signal and can especially affect cruise measurement up to 1.0 dB to 1.2 dB higher values. In a 1/3rd share of the cruise test to Lurban, the impact on Lurban is estimated up to 0.4 dB.

5) Engine conditioning – variation of temperature between runs due to warming-up routines (See note in ISO 362-1)

Taken from IWGMU-06-02 (OICA)

References:

1. Regulation 85

Observation:

Assumed that the warm-up effect relate only to the intake/charge air temperature.

Conclusion: M1 justification ”concerning operating temperatures” accepted also for N2, N3, M2, M3

Proposed coefficient:

$SPL_{p\text{-}p}$ variability: **0,8 dB**

5) Tyre conditioning – variation of temperature between runs due to warming-up routines (See note in ISO 362-1)

References:

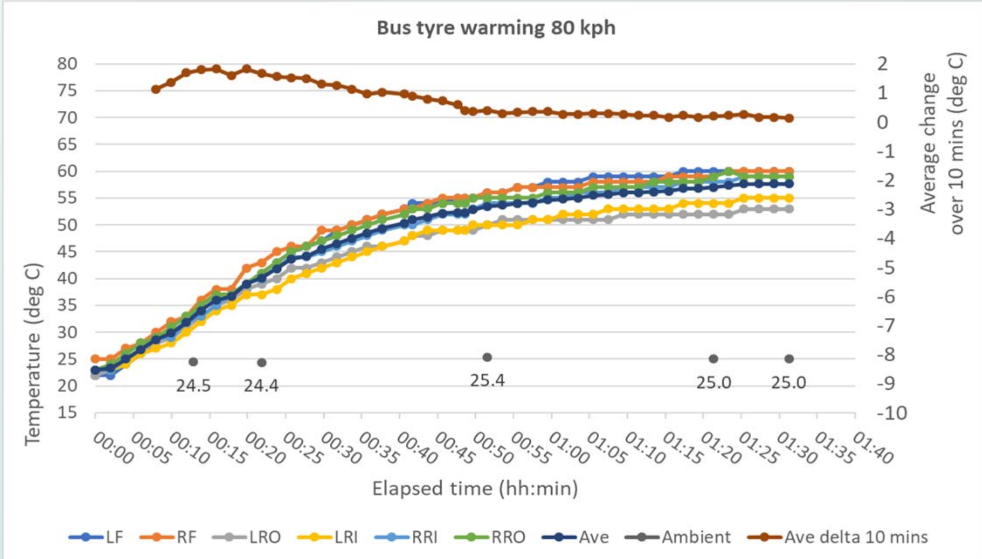
1. Reference TPMSTI-07-09
2. ISO/CD TS 13471-2, 2020-10-22

Observation:

Assumed that the warm-up effect relate only to the tyre compound/surface temperature.

Conclusion:

Proposed coefficient in combination with slide 12 (item 5).



Example from TF on TPMS (R141)
When the tyre temp is stable enough not to change during the runs. When the temp variation does not cause considerable variations in dB.
The example aim for stable conditions for inflation pressure.
(Standing still pressure = -0.16 psi (11 mBar) / min, & temp increase 7 degrees/ 26 minutes)
Reference TPMSTI-07-09

Day-to-day

Day-to-day is defined as *within the same test laboratory but* with variation of ambient conditions that can be expected during a year

- Barometric pressure (+/-50 hPa) (powertrain behavior due to air density)
- Ambient air temperature variation – +/-17,5°C (+5 to +40°C) – effect on vehicle sound due to engine power linked to air density;
- Ambient air temperature effect on **ICE vehicles** due to tyre noise between 5-40°C;

6) 7) 8) Ambient air influence on sound transmission in air (variability in impedance)

References: **IWGMU-11-06**

Observation:

According to acoustic theory.

Conclusion:

Reference temperature can be suggested as 20 deg. C.

Proposed coefficient:

Temperature: -0,015 dB/°C

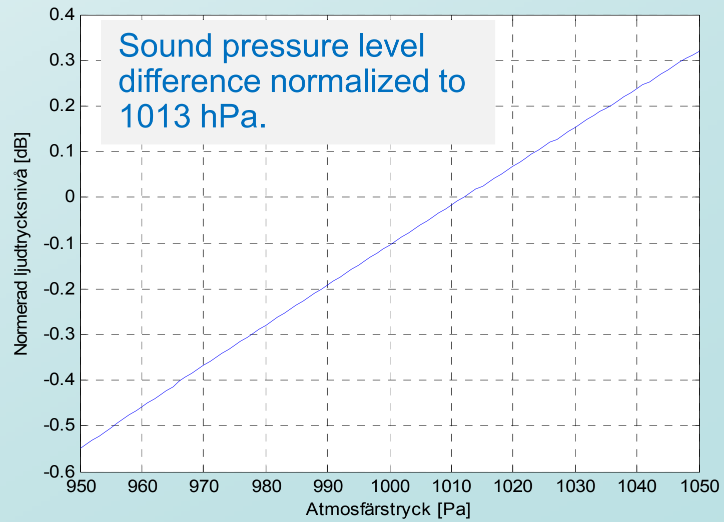
Barometric pressure: 0,009 dB/hPa

$SPL_{temp,\ p\text{-}p}$ variability: 0,6 dB

$SPL_{barometric,\ p\text{-}p}$ variability: 0,9 dB

$SPL_{humidity,\ p\text{-}p}$ variability: 0,1 dB

	Influence of humidity and temperature on sound pressure level, normalized to 5C and 0%							
	Temperature C							
Humidity %	5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C
100	-0,01	-0,10	-0,18	-0,27	-0,35	-0,44	-0,54	-0,64
90	-0,01	-0,10	-0,18	-0,26	-0,35	-0,44	-0,53	-0,62
80	-0,01	-0,09	-0,18	-0,26	-0,34	-0,43	-0,52	-0,61
70	-0,01	-0,09	-0,17	-0,25	-0,34	-0,42	-0,51	-0,60
60	-0,01	-0,09	-0,17	-0,25	-0,33	-0,42	-0,50	-0,59
50	-0,01	-0,09	-0,17	-0,25	-0,33	-0,41	-0,49	-0,57
40	-0,01	-0,09	-0,16	-0,24	-0,32	-0,40	-0,48	-0,56
30	0,00	-0,08	-0,16	-0,24	-0,32	-0,39	-0,47	-0,55
20	0,00	-0,08	-0,16	-0,24	-0,31	-0,39	-0,46	-0,54
10	0,00	-0,08	-0,16	-0,23	-0,31	-0,38	-0,45	-0,53
0	0,00	-0,08	-0,15	-0,23	-0,30	-0,37	-0,44	-0,51



9) Ambient air temperature variation – effect on vehicle sound due to engine power dependent to air density

References:

1. UN Regulation No. 85
2. ISO 15550 (Internal combustion engines — Determination and method for the measurement of engine power — General requirements)
3. ISO 2534 (Road vehicles – Gross power)
4. ISO 20762:2018 (… power for propulsion of HEV)

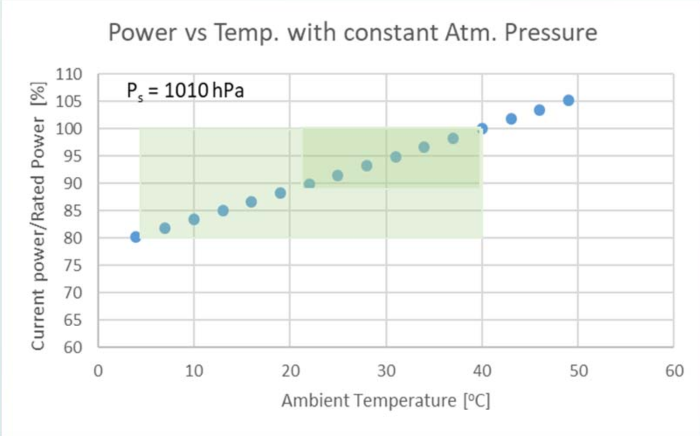
Observation:

Day-to-day variation over a year: Temperature = +/-17,5°C (+5 to +40°C)

Conclusion:

Proposed Lp-p:

Judged to be the same as for M1: SPL_{p-p} = +/-1 dB



$$P_o = P\alpha = P f_a^{\,fm} \left(\frac{99}{P_S}\right)^{0,7} \left(\frac{T}{298}\right)^{1.5}$$

P_o is the corrected power (under reference atmospheric conditions

α is the correction factor and equals $f_a^{\,fm}$

P is the measured power

f_a is the atmospheric factor

f_m is the characteristic parameter for each type of engine and adjustment

f_m = 1.2 for fuel flow, q_c higher than 40 mg/(l.cycle)

For diesel engines: 283 K ≤ T ≤ 313 K, 80 kPa ≤ Ps ≤ 110 kPa

For a test to be valid; the correction factor α must be such that 0.9 < α < 1.1.

Ref. UN Regulation No. 85

10) tyre – Temperature correction

Reference:

1. Bühlman, van Blockland LINK
2. ISO/CD TS 13471-2, 2020-10-22

Observation:

Reference 1 and 2 suggest correction factor -0,06 to -0,05 dB/°C air temperature.

Conclusion:

Reference temperature need to be defined, e.g. 20 deg. C.

Proposed coefficient for tyre noise: -0,06 dB/°C air temperature

Day-to-day includes +5 to +40 °C)

Day-to-day (ICE): 1/5 x -0,06 x 35 °C = 0,4 dB p-p

Day-to-day (EV): -0,06 x 35 °C = -2 dB p-p

11) Barometric pressure – air density effect on engine power

References:

1. UN Regulation 85, clause 5 (ISO1585, clause 6)

Conclusion:

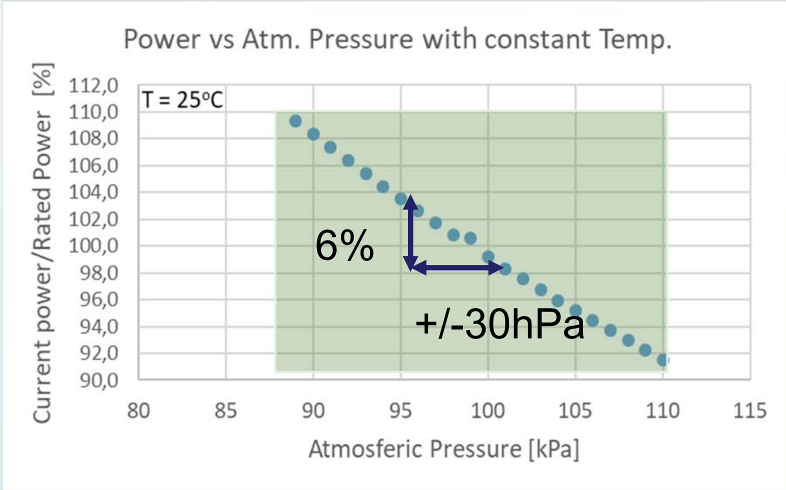
The engine torque, and thus the Sound Pressure Level can vary as a result of the variation of the density of the air due to the variation in barometric pressure and ambient temperature.

However, the combustion and the exhaust emission are under control of the ECU/ECM/PCM, the correction/dependency need further elaboration.

Proposed effect (preliminary):

Available engine power can vary by 20%, if no correction in the ECU/ECM/PCM would be applied.

Uncertainty: 6%, thus agreed to accept the estimation for M1: SPL_{p-p} = 0,4 dB (See next slide)



$$P_o = P\alpha = P f_a^{\,f_m} \left(\frac{99}{P_S}\right)^{0,7} \left(\frac{T}{298}\right)^{1.5}$$

P_o is the corrected power (under reference atmospheric conditions

α is the correction factor and equals $f_a^{\,fm}$

P is the measured power

f_a is the atmospheric factor

f_m is the characteristic parameter for each type of engine and adjustment

f_m = 1.2 for fuel flow, q_c higher than 40 mg/(l.cycle)

For diesel engines: 283 K ≤ T ≤ 313 K, 80 kPa ≤ Ps ≤ 110 kPa

For a test to be valid; the correction factor α must be such that 0.9 < α < 1.1.

Ref. UN Regulation 85

11) 12) Justification of the main impact quantities.

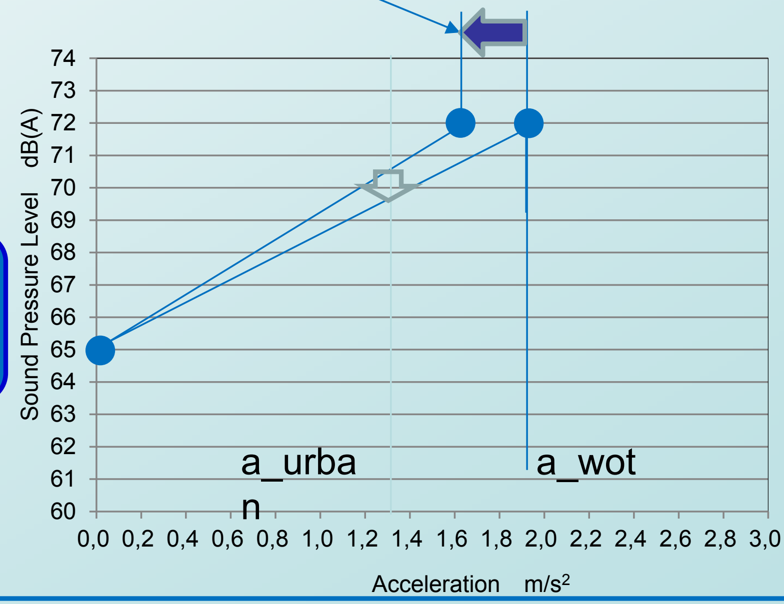
„barometric pressure“ – justification by theoretical derivation

		Barometric Pressure		Power variation	Acceleration variation	Lurban [dB(A)]
11)	Day to day	Weather +/- 30 hPa	60hPa	7.7%	7.7%	0.4dB
12)	Site to site	Altitude -1000m Location of Test Track	100hPa	13.5%	13.5%	0.7dB

ISO1585 paragraph 6.3.1
Correction of engine power; $P = \alpha_a p$
Correction factor for spark-ignition engines;

$$\alpha_a = \left(\frac{p_{ref}}{p}\right)^{1.2} \left(\frac{T}{T_{ref}}\right)^{0.6}$$

ΔSPL_{urban}: up to 0,7 dB



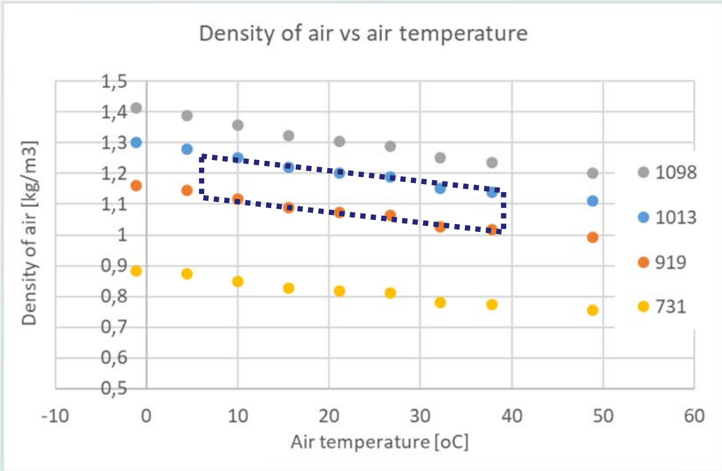
The influence of barometric pressure can be calculated by using ISO 1585 “Engine test code – Net Power”(or R85)

Site-to-site

Site-to-site is defined as variations between test laboratories where, apart from ambient conditions, equipment, staff, and road surface conditions are also different

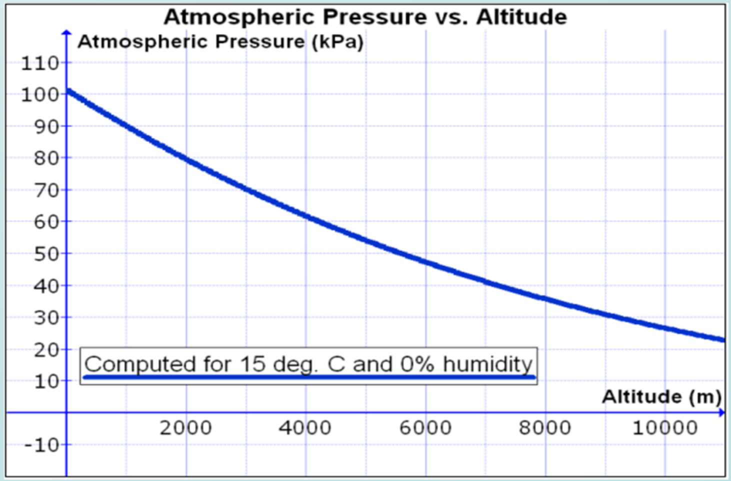
- Altitude (effect on combustion (R85) 80ka-100) and related acoustics - general approach) (0-2000 m)
- Test Track Surface
- Equipment:
  - Microphone Class 1 IEC 61672
  - Sound calibrator IEC 60942
  - Speed measuring equipment continuous at BB
  - Acceleration, Continuous speed measuring equipment, determined between PP'-BB‘
- Staff

12) Altitude effect on combustion 95-105 kPa) and on acoustics) (Range of 1000 m)



References:

1. UN Regulation 85
2. ISO 15550 (Internal combustion engines — Determination and method for the measurement of engine power — General requirements)
3. ISO 2534 (Road vehicles – Gross power)
4. ISO 20762:2018 (… power for propulsion of HEV)



Observation:
Two different aspects may be taken into account:
1) Sound propagation depend on air density. See item 7
2) Combustion/engine power depend on air density. See item 11

Conclusion: The variability of air density is 10-15% => The estimation for the M1 category was accepted: **SPL_{p-p} = 0,7 dB**

Proposed coefficient: To be further investigated by ISO.

13) Test track surface

References:

1. ISO 10844
2. VDA study on M1/C1
3. Manufacturers reports (Internal)
4. …other studies of asphalt surfaces impact to tyres and sound transmission

Observation:

ACEA members (N3): p-p 1,5 dBA

JAMA members (N2): p-p 1,3 dBA

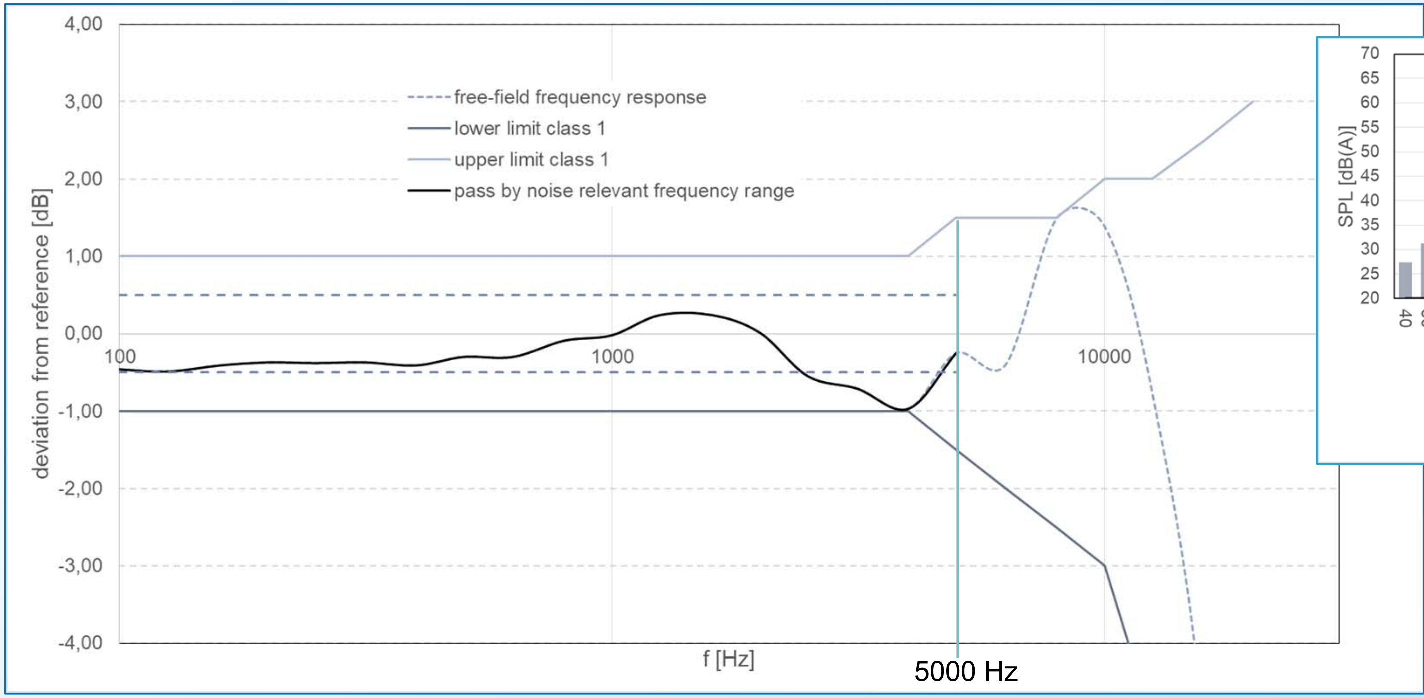
Conclusion:

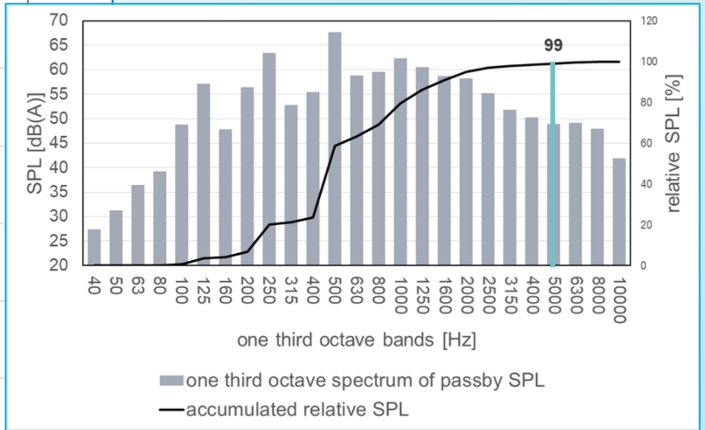
$SPL_{p\text{-}p}$ =1,3 dB

Proposed coefficient: To be further investigated by ISO.

14) Justification of the main impact quantities.

„Microphone Class 1 IEC 61672“ – justification by measurement (calibration)





ΔSPL$_{urban}$:

1 dB

▶ The deviation from reference of today used microphones is normally in a range of +/- 0.5 dB. The maximum error during measurement by using two different sound level meters can be up to 1 dB. The frequency range of interest of pass by test is up to 5000 Hz (example in the left diagram, 99% of the OAL @5000Hz)

15) Justification of the main impact quantities.

„Sound calibrator IEC 60942“ – justification by measurement (calibration)

Measurement results

sound pressure level

Set value dB	Measured value dB	Deviation from setvalue dB	Level fluctuations dB	Allowed deviation 2) dB	Confirmation
94,00	94,03	0,03	< 0,05	0,25	pass
114,00	114,02	0,02	< 0,05	0,25	pass

2) determined by DIN EN IEC 60942:2018

Excerpt from a calibration report

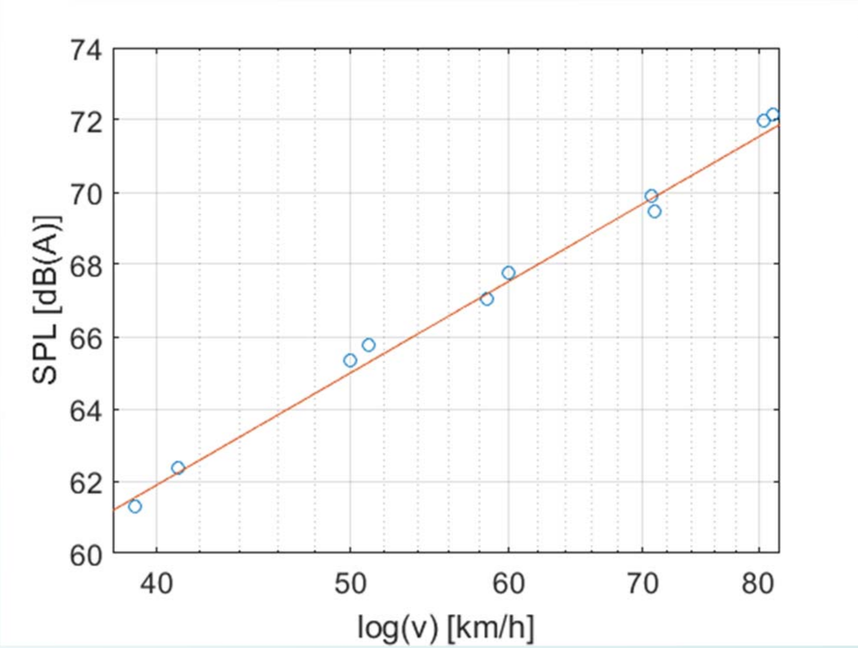
TESTO INDUSTRIAL SERVICES testo KIRCHZARTEN

ΔSPL_{urban}: 0,5 dB

The maximum allowed deviation determined by DIN EN 60942:2018 “Electroacoustics. Sound calibrators“ is +/- 0.25 dB. The maximum error during measurement by using two different sound calibrators can be up to 0.5 dB.

Copied from IWGMU-06-02 (OICA)

16) Justification of the main impact quantities.



Same approach as „DRIVER#3: speed variations of +/- 1km/h"

Precision of todays speed measuring systems: approx.:

+/-0,2 km/h

$$\Delta SPL_{TRN} = \mathbf{30} * \log\left(\frac{35{,}2km/h}{34{,}8km/h}\right) = \mathbf{0{,}148\ dB}$$

ΔSPL_{urban}:

0,1 dB

See „DRIVER#3: speed variations of +/- 1km/h"

Vehicle-to-vehicle

Vehicle-to-vehicle is defined as variations between test vehicles of the same kind where, apart from laboratories, ambient conditions, equipment, staff, and road surface conditions are also different

- Tolerances in manufacturing (COP)
- Type/Family definition (COP)
- Milage (Market Surveillance)
- Service and maintenance (Market Surveillance)
- Vehicle bodywork and equipment (Market Surveillance)

Tyre – generic dispersion (combined effect)

References:

1. Informal Document GRB-51-20 (51st GRB, 15-17 February 2010)
2. *JAMA: Drive-by noise test with 8 different tyres and one worn tyre, corrected to 15ºC.*

Observation:

- Normal tyres variations over four passage is typically within 1 dBA. (2)
- Normal tyres of different brand/model vary +/-3 dB (95% coverage interval) (3)

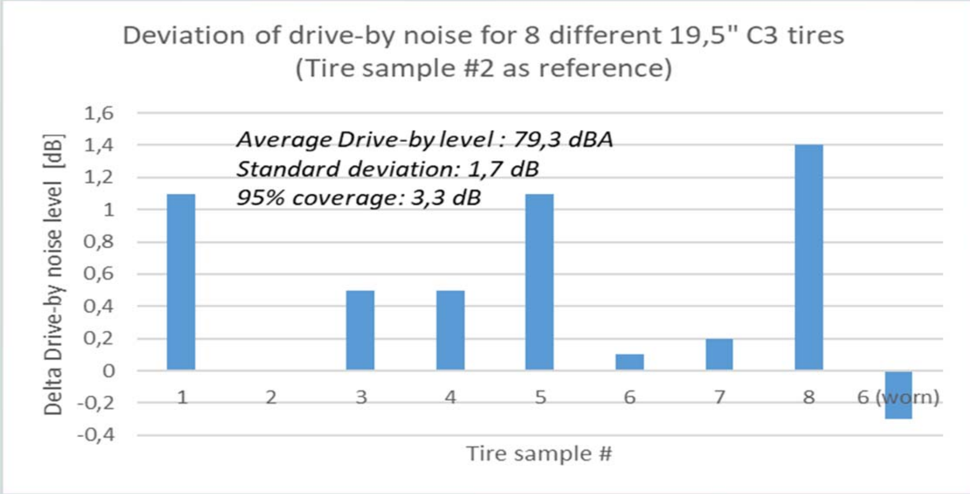
Conclusion:

- R51.03 recommends tests with normal tyres, with rib pattern.
- (The limit values where defined under the circumstances using normal tyres.) (May need further explanation in a ”reference document” at GRBP.)

Combined deviation: **$SPL_{p\text{-}p}$ = 1,7 dB**

Generic dispersion/uncertainty on total vehicle related to tyres:

- Temperature
- Rubber hardness
- Inflation pressure
- Tyre tread depth
- Torque variation
- Speed variation
- tyre brand/design



Test mass – variation as a consequence of the definition

References:

1. UN Regulation 51.03
2. …

Observation:

The test mass can deviate from vehicle to vehicle as a consequence of rated power and rear axle capacity.

Conclusion:

The resulting vehicle/engine speeds at BB' will vary within the allowed target speed window, however cause potential SPL dispersion.

Variability in acceleration can be assessed by keeping the speed at BB constant and adjust AA or vice versa.

Proposed coefficient: For further evaluation by ISO

N_2, N_3	m_{target} = 50 [kg/kW] x P_n [kW] Extra loading, m_{xload}, to reach the target mass, m_{target}, of the vehicle shall be placed above the rear axle(s). The sum of the extra loading and the rear axle load in an unladen condition, $m_{ra\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ max}$. The target mass shall be achieved with a tolerance of ±5 per cent. If the centre of gravity … The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle. If the vehicle mass of a vehicle with more than two axles in an unladen condition, $m_{unladen}$, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading. If the vehicle mass of a vehicle with two axles, $m_{unladen}$, is greater than the target mass, then this vehicle shall be tested without extra loading.

EV battery state of charge

References:

1. Official source
2. Manufacturers report??

Observation:

Conclusion:

Proposed coefficient: To be further developed in ISO.

Background documents

Tyre – torque influence

References:

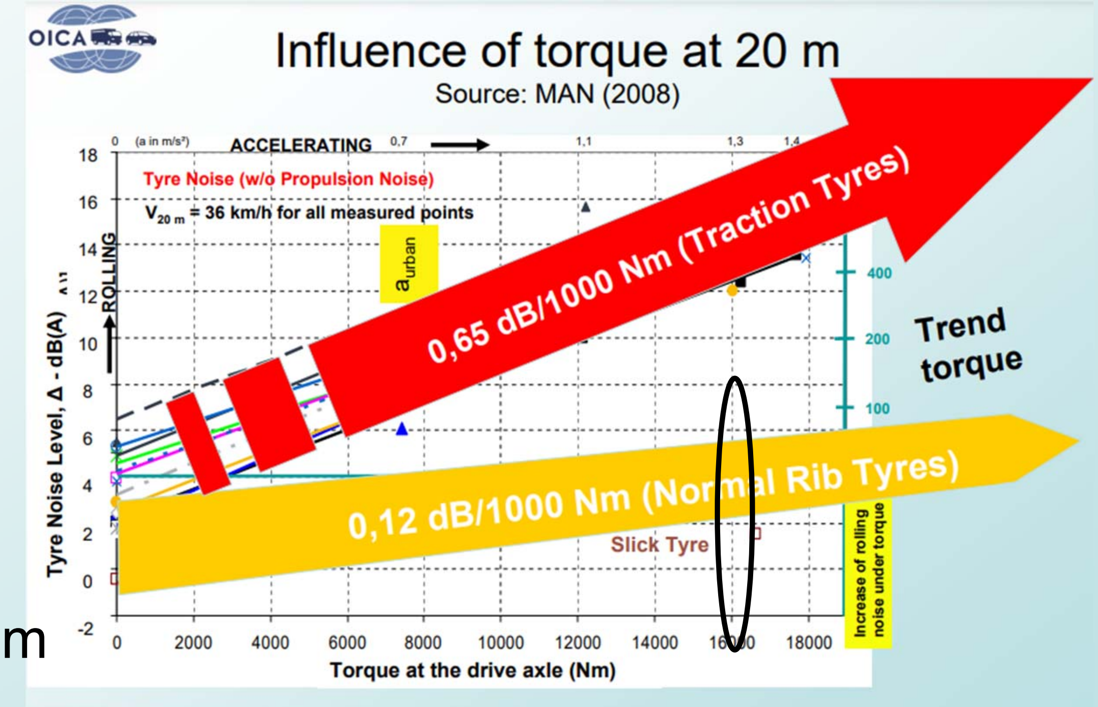
1. GRBP Session 51
2. Manufacturers report??

Observation:

Conclusion:

(tyre effect) 0,12 dB/kNm at drive axle

(vehicle effect) 0,12 x 1/5 = 0,024 dB/kNm



Tyre – normal vs traction tyres

References:

1. GRB-51-20 (51st GRB, 15-17 February 2010)
2. GRB-53-17 (53rd GRB, 15-17 February 2011)
3. Mogrovejo, Flintsch, de León Izeppi and McGhee - *Effect of Air Temperature and Vehicle Speed on tyre/Pavement Noise Measured with On-Board Sound Intensity Methodology* - https://www.irf.global/wp-content/uploads/Mogrovejo.pdf

Observation:

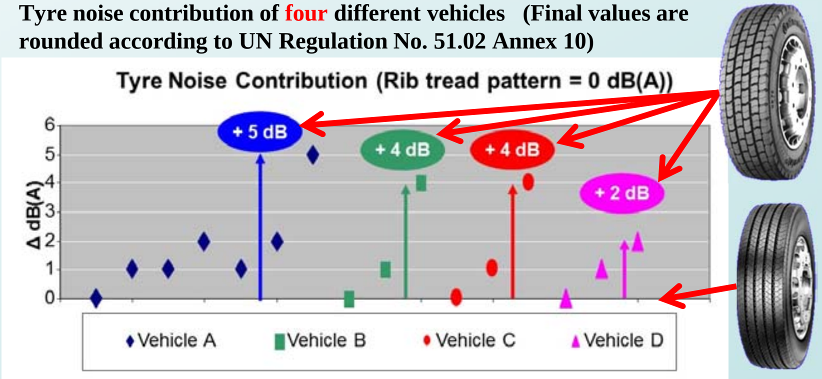
Ref. 1 & 2 Tyres with block tread pattern on the drive-axle can vary stochastically, due to the tonality of such tyres, with consequences to run-to-run uncertainty. Ref. 3 explain for C1 tyres: "The model shows a gradient of approximately -0.05 dBA/°F. Regarding the influence of vehicle speed, the test showed that for the surface studied tyre/pavement noise increases an average of 2.5 dBA for every 10 mph of increased speed."

Conclusion: R51.03 recomends tests with normal tyres, with rib pattern.

Proposed coefficient for tyre contribution:

- C3 Rib tyres (Ref.): 0,4 dB/(km/h)
- C3 Lug tyres (Ref. 2): 0,6 dB/(km/h)
- C1 tyres (Ref. 3): 0,25 dB/mph

Tyre noise contribution of four different vehicles (Final values are rounded according to UN Regulation No. 51.02 Annex 10)



Ref. 2: