Drive-by noise test

Measurement Uncertainty
(Application to Vehicle Categories M3/N3)

STATUS REPORT: Barometric pressure

Referring to ISO 362-1/R51.03

Prepared for UNECE GRBP IWG-MU

Members of OICA prepared this document.

2021-04-21

Document under development, only for IWG-MU review.

Drive-by noise test

Measurement Uncertainty
(Application to Vehicle Categories M3/N3)

STATUS REPORT: Barometric pressure

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

Sturk, Solhkonan, Klopotek, Hirata, Yatsu, Heuer, Schremmer, Arakawa

2021-04-21

Document under development, only for IWG-MU review.

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 Conbined 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.

11) Barometric pressure – air density effect on engine power

References:

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

Conclusion:

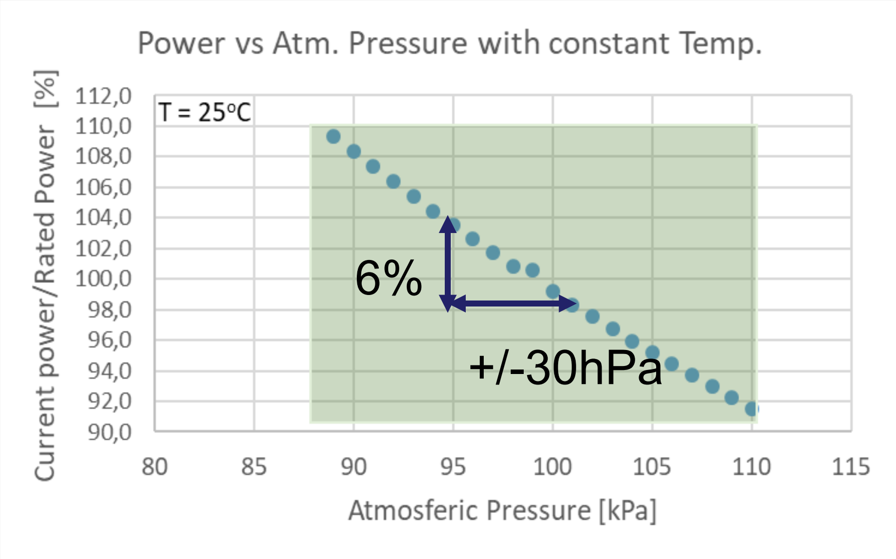
The engine torque, and thus the Sound Pressure Level can vary as a result of the variation of the density of the air due to the variation in barometric pressure and ambient temperature.

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

Proposed effect (preliminary):

Uncertainty: 6% (confirming the estimation for M1)

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

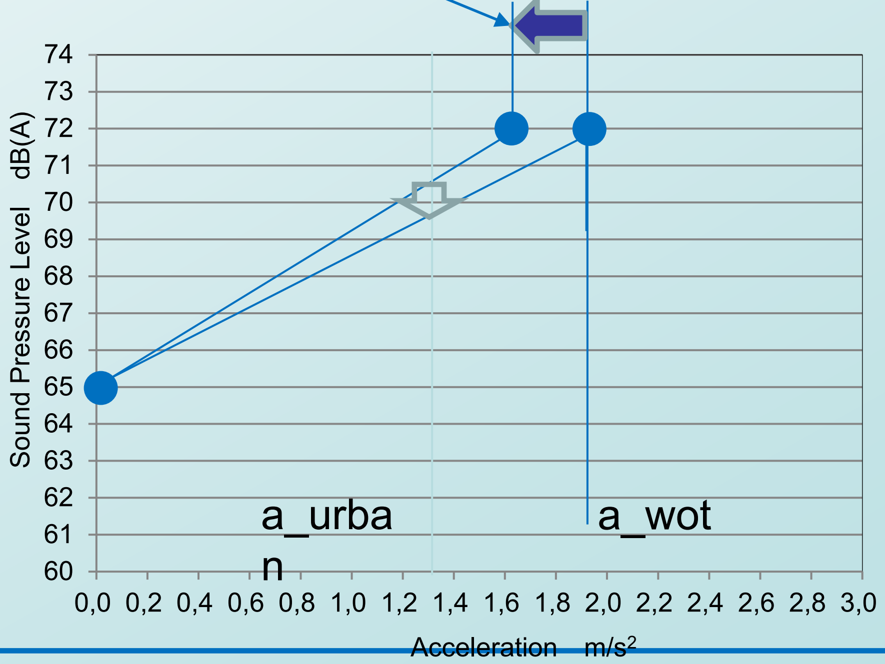
		Barometric Pressure		Power variation	Acceleration variation	Lurban [dB(A)]
11)	Day to day	Weather +/- 30 hPa	60hPa	7.7%	7.7%	0.4dB
12)	Site to site	Altitude -1000m Location of Test Track	100hPa	13.5%	13.5%	0.7dB

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

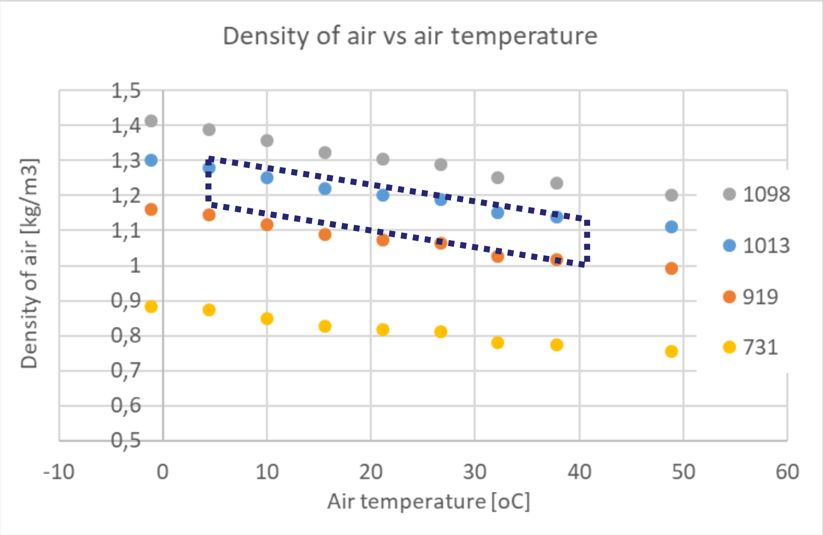


The influence of barometric pressure can be calculated by using ISO 1585 "Engine test code – Net Power"(or R85)

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

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: Air density varies about 10%

Proposed coefficient:

➢ To be further developed