ROLLING SOUND EMISSION MODULE

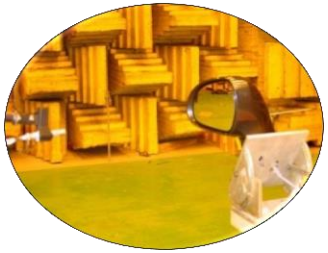
ECE R117 REGULATION

UTAC CERAM's NVH in figures

NVH testing and expertise

Exterior vehicle noise testing

Equipment and machine noise and vibrations testing



Semi-anechoic chamber

4-posts bench suspension bench

Our current experience on exterior testing

- More than 40 years of collaboration with manufacturers suppliers and authorities for regulation, Approval, COP and expertise
- All type of vehicle tested (2-3 wheels, light and heavy duty vehicles, agricultural tractor, …)
- Worldwide recognition (EU, ECE, Japan, Taiwan, …), ISO 17025, …
- ISO 10 844 building and certification
- ISO/WG42 and UNECE/WP29/GRB participation
- Others services linked to pass-by noise such as round robin tests, uncertainties evaluations, cost benefits analysis, …

Regulations and standardization

Regulation's constraints

- **Sound levels of tyres :**
  - Regulation GRS CE/661/2009 and ECE 117R02
  - Labelling - CE/1222/2011

  Reduction from 2 to 4 dB before 2016

- **Sound levels of 4 wheel (and more) vehicles :**
  - Regulation CE/540/2014 and ECE 51R03

  Reduction from 3 to 4 dB before 2026

- **Audibility of electrified vehicles :**
  - Regulation CE/540/2014 and ECE xxx

  Minimum sound level before 2019

- **Sound levels of 2-wheels vehicles :**
  - Regulation CE/168/2013 and ECE 41R02

  Time Schedule and reductions in progress

Worldwide working groups

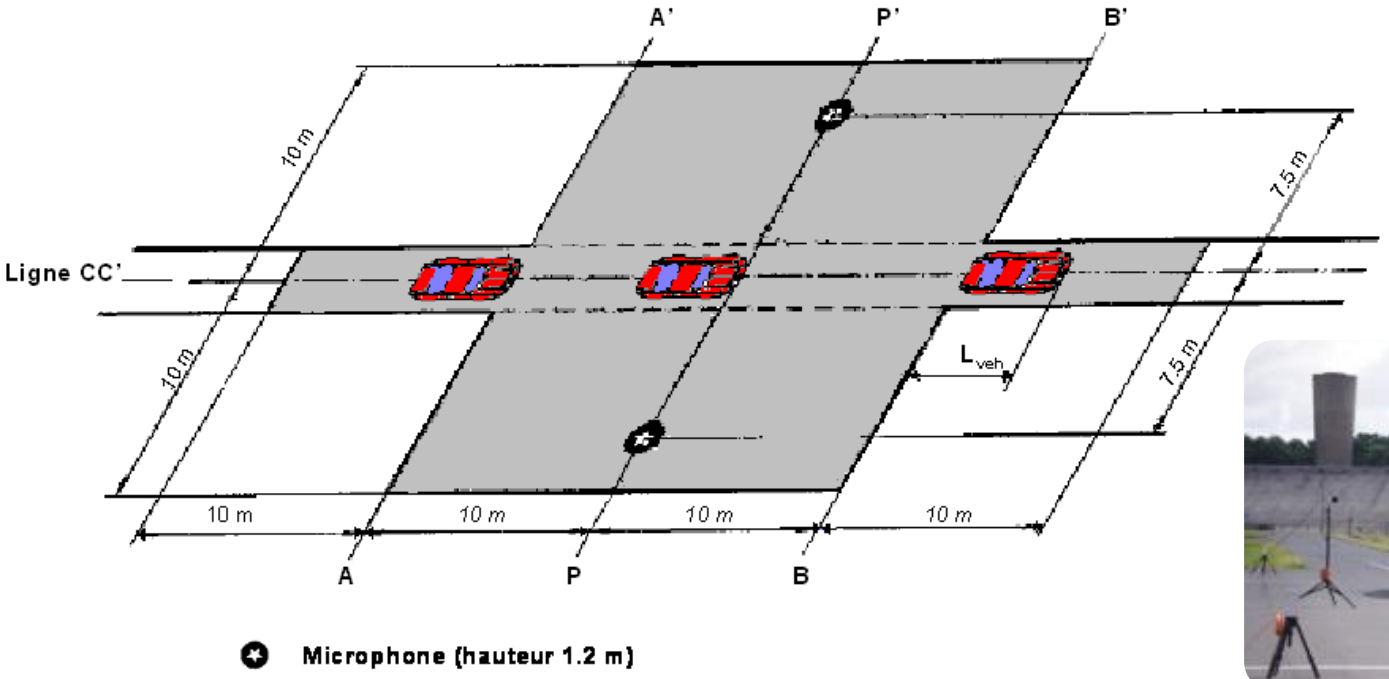
- **For automotive standardization :**
  - ✓ ISO/TC43/SC1/WG42 (vehicle noise group)
  - ✓ ISO/TC 31 (tyre group)

- **For Automotive Regulation**
  - **United nations** :
    - ✓ UNECE/WP 29 : World Forum for Harmonization of vehicle regulations
    - ✓ GRB : Working Party of Noise (Geneva)
  - **European commission**, parliament and of the council (Labelling))

ECE117 : Noise testing method

ECE117 Testing method principle

- On track, microphone 7,5 m, 1,2 m height
- Coast by method



Tyres conditions

- **Tyre load :**
  - ✓ Load for each tyre Q_t between 50 % et 90 % of reference load Q_r
  - ✓ Mean load Q_t equal to 75 % ± 5 % of reference load Q_r

$$P_r(Q_t/Q_r)^{1,25} \leq P_t \leq 1,1\ P_r(Q_t/Q_r)^{1,25}$$

➔ **To have same foot print whatever vehicle choosen**

Tyres conditions

- **Tyre pressure inflation :**
  - ✓*C1 standard : P_r = 250 kPa*
  - ✓*C1 enforced : P_r = 290 kPa*
  - ✓*C2 et C3 : P_r correspond to tyre pressure index (Writing on the tyre)*

- **Tyre shall be warmed before measurement**

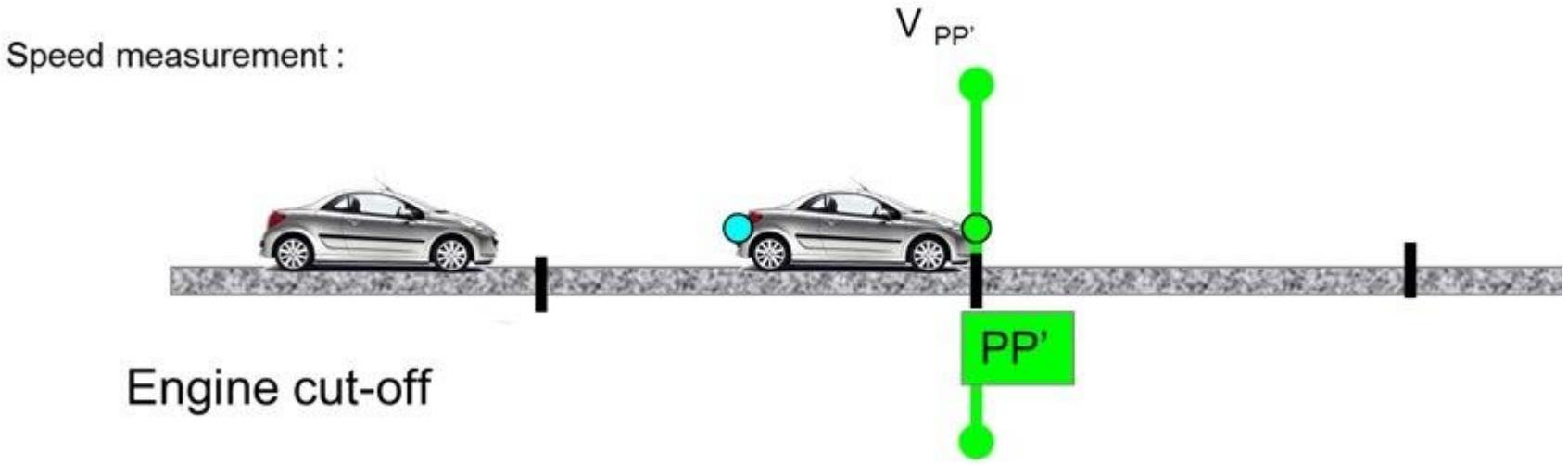
Meteorological conditions

- **The measurements shall be made with :**
  - ✓ **ambient air temperature** within the range from **5 °C to 40 °C**
  - ✓ **track temperature** within the range from **5 °C to 50 °C**
  - ✓ **wind speed** not exceeding 5 m/s during the sound measurement interval

➔ A value representative of temperature, wind speed and direction, relative humidity and barometric pressure shall be recorded during the sound measurement interval

Coast by conditions

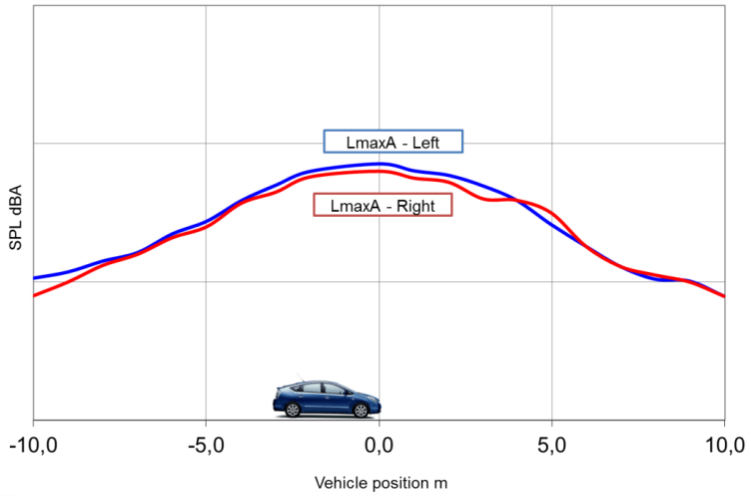
- 8 passes from V_{Ref} - 10 km/h to V_{Ref} + 10 km/h :
  - ✓ *V_{Ref} = 80 km/h for C1 and C2 class tyre*
  - ✓ *V_{Ref} = 70 km/h for C1 and C2 class tyre*



Coast by conditions

➢ Critical measurements :

- ✓ Maximum sound level left and right (dB(A))
- ✓ Speed at PP' (km/h)
- ✓ Surface temperature (°C)



ECE117 Processing

➢ Temperature correction :

- ✓ LR (T_{Ref}) = LR (T) + **K** (T_{Ref} - T)
- ✓ T = surface temperature
- ✓ T_{Ref} = 20 °C

→ **C1 :**

- Coefficient **K** is -0,03 dB(A)/°C for T > Tref
- Coefficient **K** is -0,06 dB(A)/°C for T < Tref

→ **C2 :**

- Coefficient **K** is -0,02 dB(A)/°C for T > Tref

→ **C3 :** No correction

ECE117 Processing

➢ Logarithmic regression :

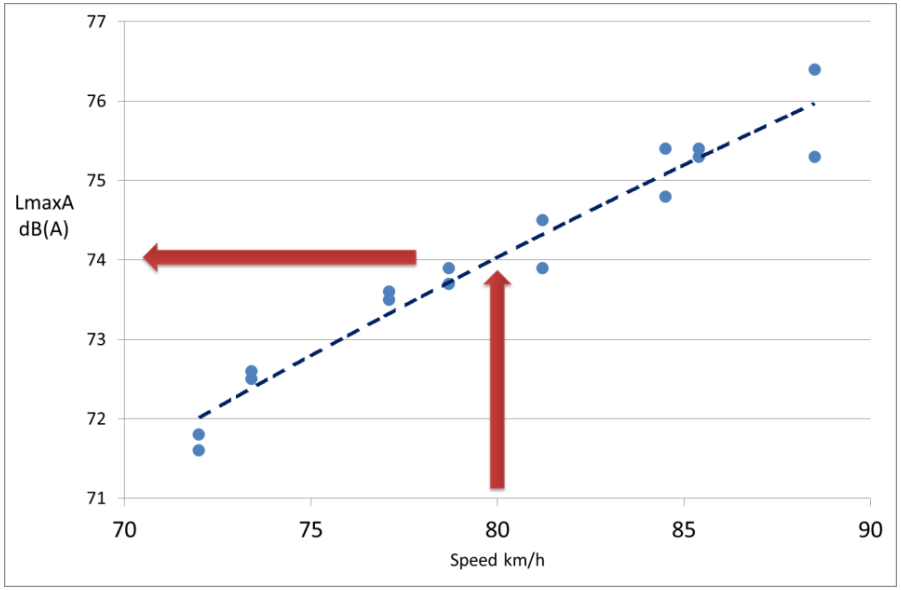
$$L = L_{ref} - a \times \log\left(\frac{V}{V_{ref}}\right)$$

$$a = \frac{\sum_{i=1}^{n}(v_i - \bar{v})(L_i - \bar{L})}{\sum_{i=1}^{n}(v_i - \bar{v})}$$

$$L_{ref} = \bar{L} - a\bar{v}$$

$$v_i = \log\left(\frac{V_i}{V_{ref}}\right)$$

$$L_{ref} = \bar{L} - a\bar{v}$$



- Order to take account of any measuring instrument inaccuracies, the results shall be reduced by 1 dB(A)
- The final result, in dB(A), shall be rounded down to the nearest lower whole value

Example

Load index	94	Load Qr		670 kg	
	Front left	Front right	Rear left	Rear Right	Total [70; 80] % Qr
Poids à vide avec chauffeur					0 kg
Qt min (50% de Qr)	335 kg	335 kg	335 kg	335 kg	**1876 kg**
Qt min (90% de Qr)	603 kg	603 kg	603 kg	603 kg	**2144 kg**
Qt	**538 kg**	**501 kg**	**428 kg**	**426 kg**	**1893 kg**
Qt/Qr	80%	75%	64%	64%	71%

PRESSION DES PNEUMATIQUES					
Pressure Pr	290 kPa	C1	C1 Extra Load	C2, C3 (flanc du pneu)	
		250 kPa	290 kPa		0 kPa
	Front left	Front right	Rear left	Rear Right	
Pt min	220 kPa	202 kPa	166 kPa	165 kPa	
Pt max	242 kPa	222 kPa	182 kPa	181 kPa	
Pt à froid en kPa	230 kPa	210 kPa	180 kPa	180 kPa	100 kPa = 1 bar

Example

Speed	Sound level		Température Air	Température Surface	Corrected sound level	
PP'	MAX Gauche	MAX Droit			MAX Gauche	MAX Droit
(km/h)	(dB(A))	(dB(A))	(°C)	(°C)	(dB(A))	(dB(A))
70,9	69,3	68,8	19	25	69,5	69,0
74	70,1	70,5	18	26	70,3	70,7
75,3	70,4	71,1	19	25	70,6	71,3
79	70,8	71,7	20	25	71,0	71,9
81	71,3	72,3	18	25	71,5	72,5
83,6	72,3	72,5	21	27	72,5	72,7
86,1	73,4	73	21	27	73,6	73,2
87,5	73	73,8	17	25	73,2	74,0

RESULTATS ECE 117			
a	LR à V ref	Arr.inf LR	Arr LR - 1dB
45,1	71,8	71,0	70,0

ECE117 Limits

- Stage 2 : New type from 11/2012
- Stage 2 : All type from 2016

C1 tyre class

Stage 1	
Nominal Section Width	*Limit dB(A)*
145 and lower	72
Over 145 up to 165	73
Over 165 up to 185	74
Over 185 up to 215	75
Over 215	76
The above limits shall be increased by 1 dB(A) for extra load tyres or reinforced tyres and by 2 dB(A) for "special use tyres".	

Stage 2	
Nominal Section Width	*Limit dB(A)*
185 and lower	70
Over 185 up to 245	71
Over 245 up to 275	72
Over 275	74
The above limits shall be increased by 1 dB(A) for snow tyres, extra load tyres or reinforced tyres, or any combination of these classifications.	

ECE117 Limits

C2 tyre class

Stage 1	
Category of use	*Limit dB(A)*
Normal	75
Snow (*)	77
Special	78

Stage 2	
Category of use	*Limit dB(A)*
Normal	72
Snow	73
Special	74
In case of traction tyres, the above limits shall be increased by 1 dB(A) for category of use normal and special, and by 2 dB(A) for category of use snow.	

C3 tyre class

Stage 1	
Category of use	*Limit dB(A)*
Normal	76
Snow (*)	78
Special	79

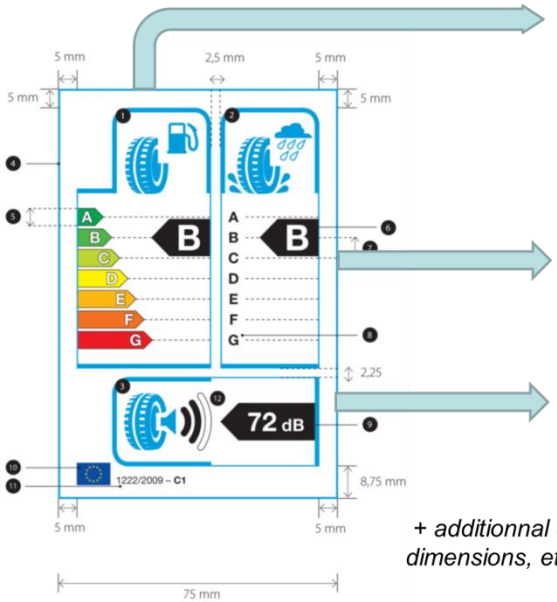
(*) Limit applies also to tyres marked M+S only.

Stage 2	
Category of use	*Limit dB(A)*
Normal	73
Snow	74
Special	75
In case of traction tyres, the above limits shall be increased by 2 dB(A).	

Rolling noise – Labelling

- ***Mandatory after 1st of november 2012 :***
  - ✓ *Either by a sticker on the tread of the tyre*

    or
  - ✓ *A labelling printed format attached to the lot of identical tyres*



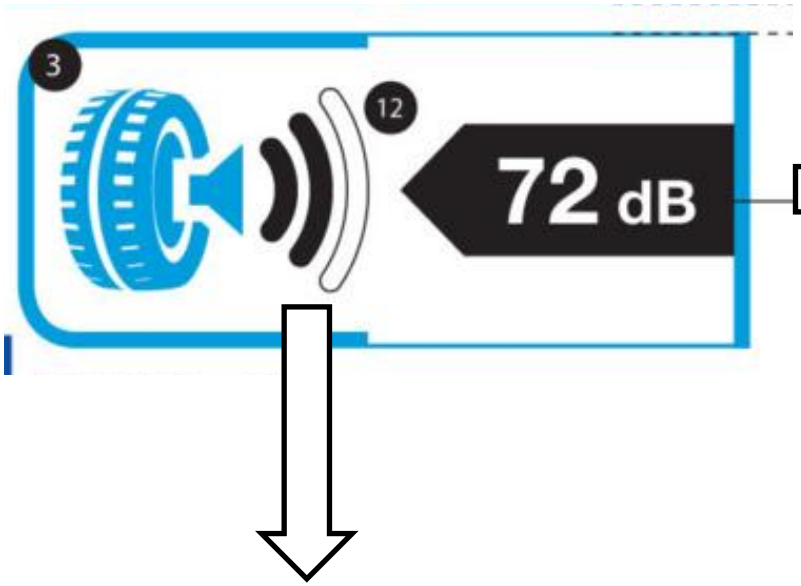
Class of energy in link with the rolling resistance.

Class of safety in link with the wet grip.

Class of noise in link with the acoustic level.

+ additionnal datas (e.g: trademark, dimensions, etc.)

Rolling noise – Labelling



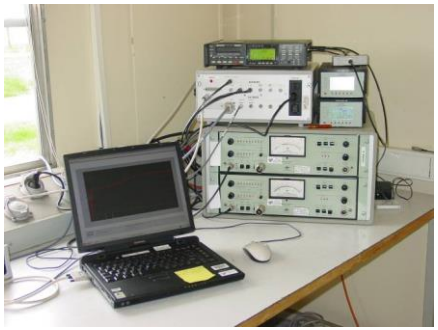
Labelling level

1 wave : Fulfils stage 2 – 3 dB
2 waves : Fulfils stage 2
3 waves : Fulfils stage 1

Measurement equipements

Sound meter level

- **Sound level meter or equivalent measurement system**
- Class 1 instruments (inclusive of the recommended windscreen, if used). These requirements are described in IEC 61672-1.



Compliance shall be verified at least every 2 years

The entire measurement system shall be checked with sound calibrator that fulfils the requirements of Class 1 sound calibrators according to IEC 60942.

Compliance shall be verified once a year

Sound meter level

- Measurements shall be carried out using the time weighting "F" of the acoustic measurement instrument and the "A" frequency weighting curve also described in IEC 61672-1
- When using a system that includes periodic monitoring of the A-weighted sound pressure level, a reading should be made at a time interval not greater than 30 ms
- The instruments shall be maintained and calibrated in accordance with the instructions of the instrument manufacturer

dB(A) ..... dB(A)
FAST .....F
Maximum level maintain ..... MaxL

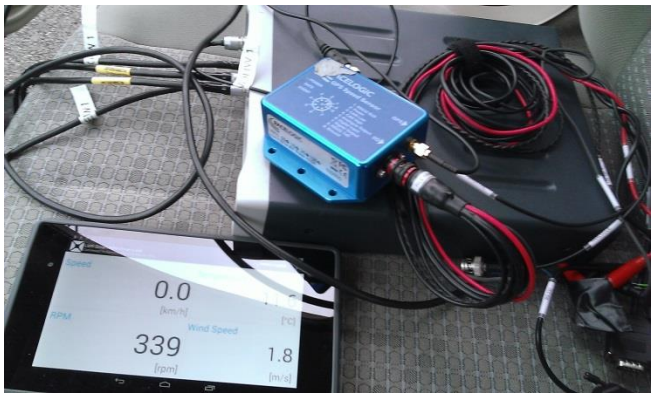
Sound meter level

- **Calibration :**
  - ✓ At the beginning and at the end of every measurement session
  - ✓ Without any further adjustment, the difference between the readings shall be less than or equal to 0,5 dB
  - ✓ If this value is exceeded, the results of the measurements obtained after the previous satisfactory check shall be discarded

Speed measurements

- The road speed of the vehicle shall be measured with instruments meeting specification limits of at least **± 0,5 km/h when using continuous measuring devices** (radar, code wheel, GPS)

- If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least ± 0,2 km/h.

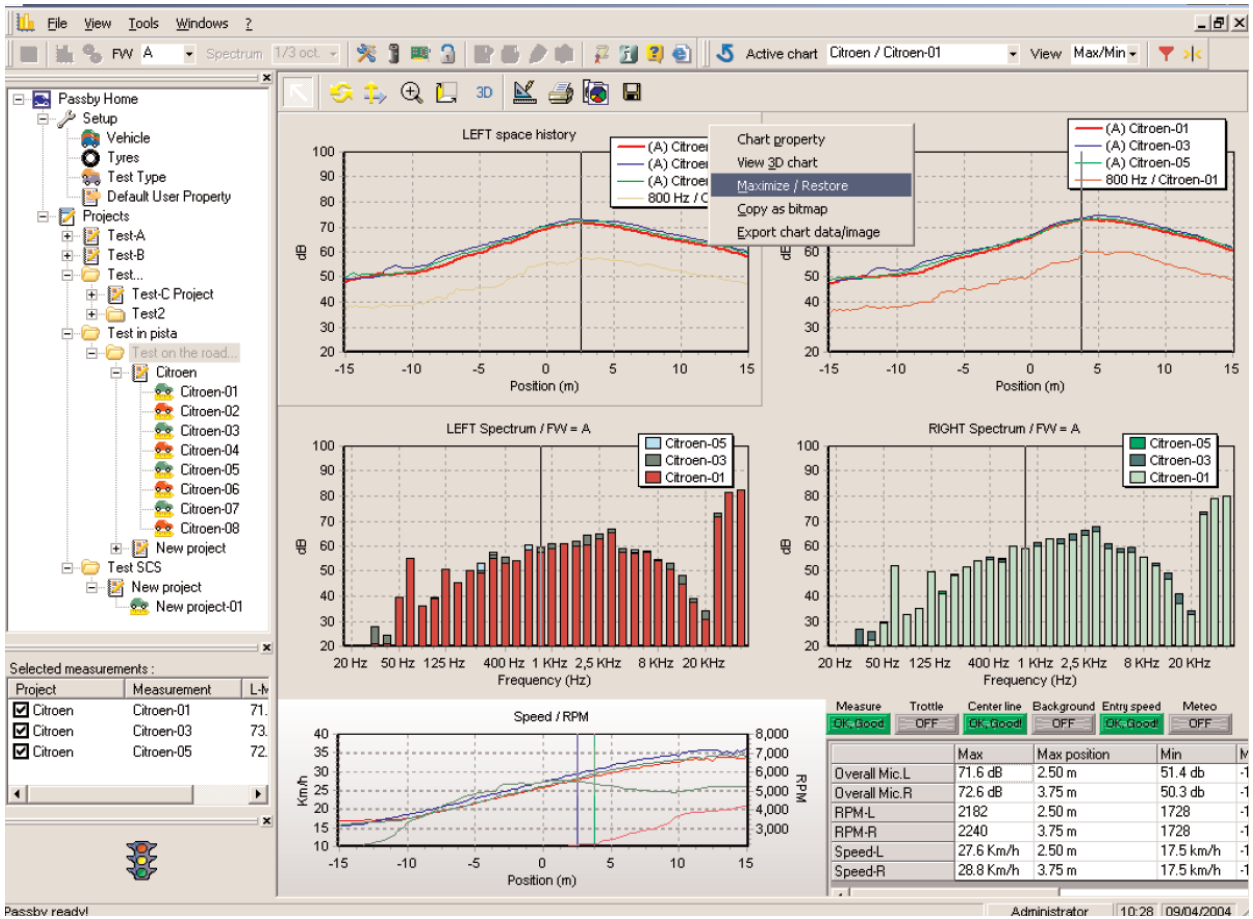


Meteorological instrumentation

- at least ± 1 °C for a temperature measuring device
- at least ± 1,0 m/s for a wind speed measuring device
- at least ± 5 hPa for a barometric pressure measuring device
- at least ± 5 % for a relative humidity measuring device

- The meteorological instrumentation shall deliver data representative of the test site, and shall be positioned adjacent to the test area at a height representative of the height of the measuring microphone

Full measurement system

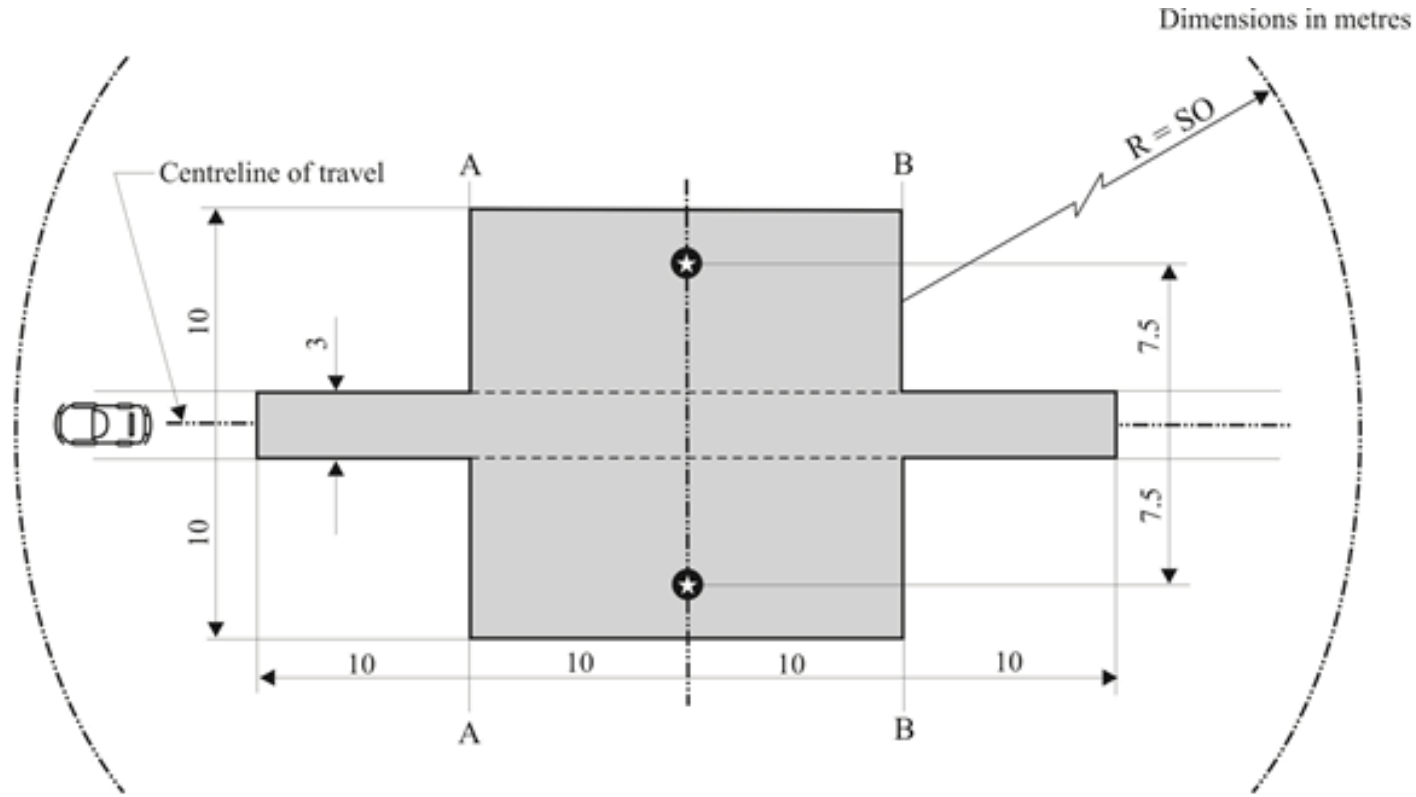


Test track ISO 10844

The test site shall be substantially level. The test track construction and surface shall meet the requirements of ISO 10844

- Free of large reflecting objects such as fences, rocks, bridges or buildings
- In the vicinity of the microphone, there shall be no obstacle that could influence the acoustical field and no person shall remain between the microphone and the noise source. The meter observer shall be positioned so as not to influence the meter reading

Test track ISO 10844



Key ▭ Minimum area covered with test road surface, i. e. test area

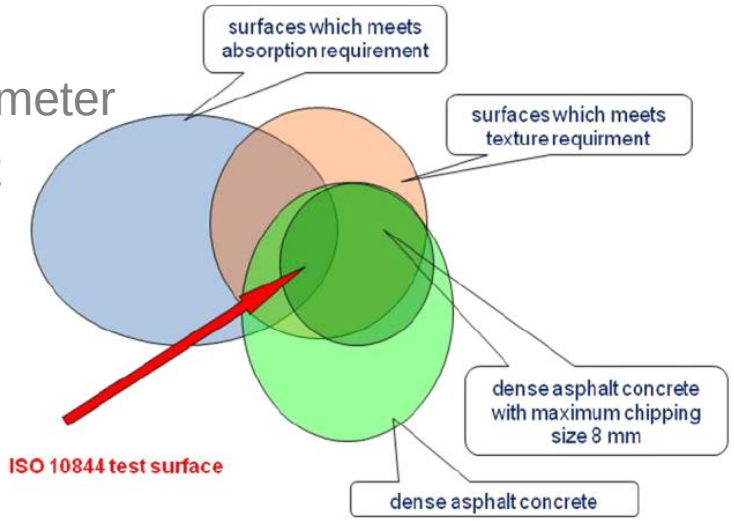
✪ Microphone (height 1,2 m)

NOTE - There shall be no large acoustically reflective objects within this radius.

New test track – ISO 10844 specifications

- ISO working group started in 2003 adjust the standard with the goal of defining a new surface design which :
  - ✓ produces consistent levels of tyre/road sound emission
  - ✓ minimizes inter-site variation
  - ✓ provides negligible absorption of the vehicle sound sources

- The influencing parameters by weight on tyre/road noise are classified in the following order :
  - ✓ The surface texture is the key factor
  - ✓ The absorption is the second important parameter
  - ✓ The mechanical impedance is less important



New test track – ISO 10844 specifications

- **ISO 10844 specifications :**
  - ✓ Dense asphaltic concrete
  - ✓ Maximum chipping size from 6,3 to 10 mm
  - ✓ Thickness of the wearing course ≥ 30 mm

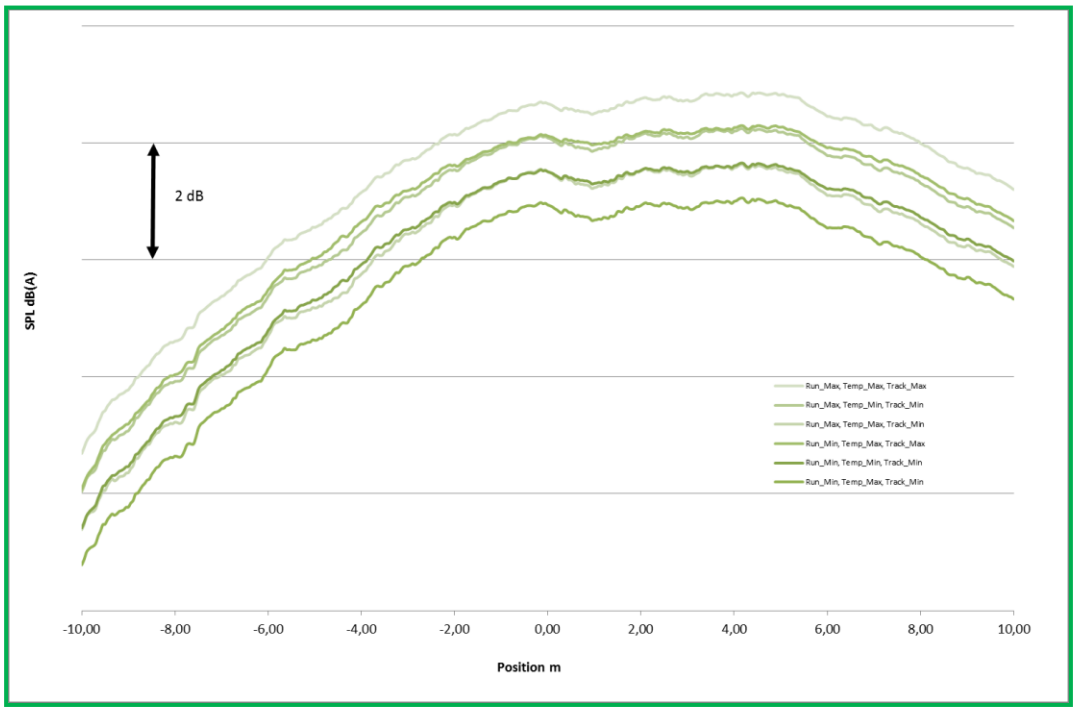
- **1994 standard :**
  - ✓ Residual void ≤ 8% or sound absorption ≤ 10%
  - ✓ Macro texture depth ≥ 0,4 mm

- **2011/2014 standard :**
  - ✓ Grading curve
  - ✓ Mean profile depth 0,5 ± 0,2 mm
  - ✓ Sound absorption ≤ 8% (drive lane) and 10% (propagation area)
  - ✓ Geometry (irregularity, deviation)

Measurements method for development

Knowledge on variability

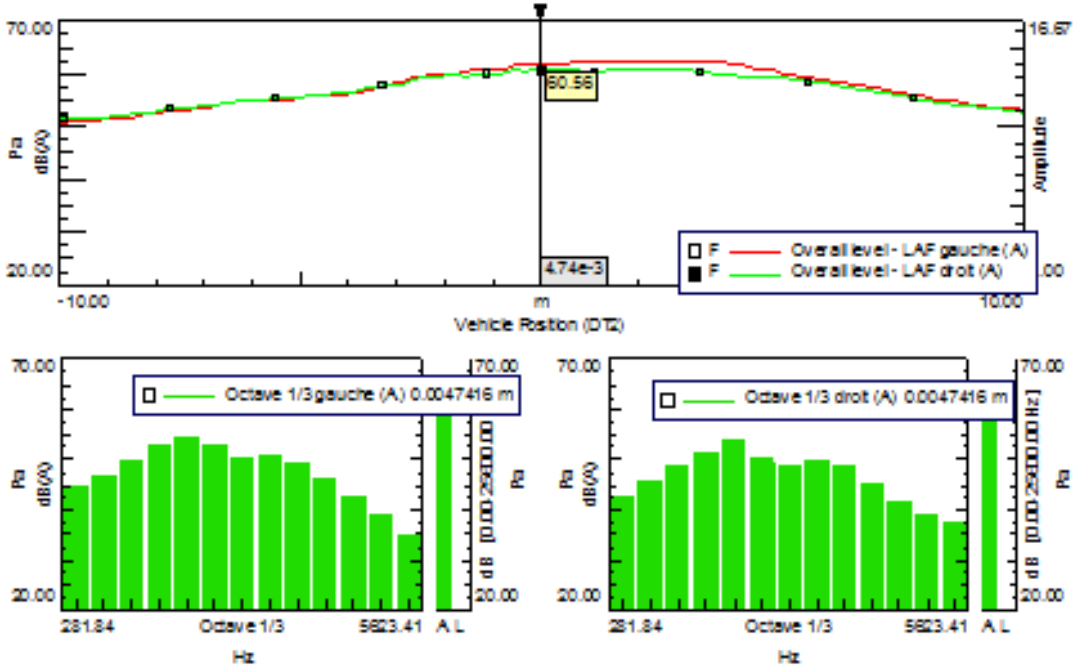
- More than 2 dB regarding testing conditions



Run to run
Day to day
Site to site

Analysis on track

- For first analysis, Overall and 1/3 oct band level analysis performed directly on the pass-by

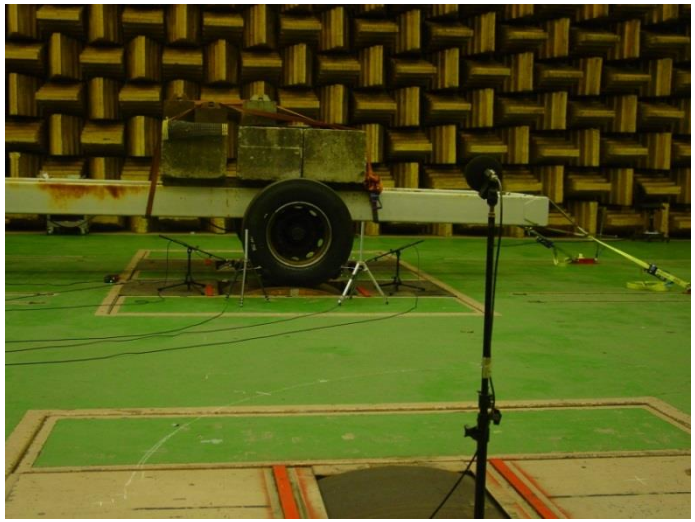


Analysis for automotive customers

- Tests on «Silent vehicle»
- Tests on automotive regulation regulation conditions :
  - ✓ 50 km/h
  - ✓ Weight and tyre inflation from vehicle

Tests on bench

- Tests on drum :



- Indoor testing :