« AUTOMOTIVE IN SOUNDSCAPE »
FUTURE OF PASS BY NOISE REGULATION AND THEIR IMPACT ON CITY LIFE

PRESENTED BY THOMAS ANTOINE (RENAULT) TO:
UNECE OCT 26TH & 27TH 2021
Worgroup purpose

« Our purpose is to better understand and analyze the noise emission regulation applied to the automotive OEM and suppliers as NVH experts, embracing a broad vision: from noise sources to the environmental acoustics and urban soundscape »

Workgroup members:
Regulatory panorama
Context:
Objectives of the Pass-By Noise Regulation

Our understanding of Pass-by noise regulation purposes:

- **Environmental protection**
- **Public Health and Safety**
- **Improve Quality of life**

In a word: progress – and progress has a meaning if it is shared by everyone.
## Regulation panorama: for Vehicles / Tires / Roads

<table>
<thead>
<tr>
<th>Run up (acceleration)</th>
<th>Constant speed</th>
<th>limit dependent on</th>
<th>T°C correction</th>
<th>Pass by noise for vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>50 kph</td>
<td>Nothing</td>
<td>No</td>
<td>UN/ECE R51</td>
</tr>
<tr>
<td>No</td>
<td>80 kph</td>
<td>Tire width</td>
<td>Yes</td>
<td>EC 661 R117</td>
</tr>
<tr>
<td>No</td>
<td>40 kph</td>
<td>?</td>
<td></td>
<td>ISO 11819</td>
</tr>
</tbody>
</table>

50 KpH and run up mix Level not dependent on Tire width

Inconsistencies between all these standards
Regulation panorama: Noise in the Environment

Directive 2002/49/CE

Population survey  Short- or long-term measurements  Modelling and mapping
Workgroup Roadmap and focus
Global mindmap

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**Action scope**
- Car construction
- Tire construction
- Road construction

**Environment control**
- Regulatory Source control
  - ISO 10844
  - ISO 11819
  - R51
  - R117

**Modelled Environment**
- City layout
- City traffic organization
- Traffic regulations
- Weather corrections
- Car usage
- Rolling/traction split
- Road category

**Real environment**
- Real layout
- Real traffic
- Real behavior
- Real weather
- Real car usage
- Real tire state
- Real road state

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**Human perception & annoyance**
- Sonie, harshness, loudness...

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**dBA**
# 1st step Review real usage with R51 Homologation

<table>
<thead>
<tr>
<th>Car construction</th>
<th>Tire construction</th>
<th>Road construction</th>
<th>Action scope</th>
</tr>
</thead>
</table>

### Environment control

<table>
<thead>
<tr>
<th>Regulatory Source control</th>
<th>Modelled Environment</th>
<th>Real environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 10844</td>
<td>City layout</td>
<td>Real layout</td>
</tr>
<tr>
<td></td>
<td>City traffic organization</td>
<td>Real traffic</td>
</tr>
<tr>
<td></td>
<td>Traffic regulations</td>
<td>Real behavior</td>
</tr>
<tr>
<td></td>
<td>Weather corrections</td>
<td>Real weather</td>
</tr>
<tr>
<td></td>
<td>car usage</td>
<td>Real tire state</td>
</tr>
<tr>
<td></td>
<td>Rolling/traction split</td>
<td>Real road state</td>
</tr>
<tr>
<td></td>
<td>Road category</td>
<td></td>
</tr>
</tbody>
</table>

### Human perception & annoyance

- Sonie, harshness, loudness...

- dbA

- 2002/49/CE

- ISO 11819
2nd step: review consistency between UN-R51/R117

Homologation
- Declaration
- Weather cond. & corr.

Modelled Environment
- 2002/49/CE
- City layout
- City traffic organization
- Traffic regulations
- Weather corrections
- Car usage
- Rolling/traction split
- Road category

Real environment
- Real layout
- Real traffic
- Real behavior
- Real weather
- Real car usage
- Real tire state
- Real road state

Human perception & annoyance
- DBA
- Sonie, harshness, loudness...
3rd step: review metrics

- Car construction
- Tire construction
- Road construction

Action scope

Modelled Environment
- City layout
- City traffic organization
- Traffic regulations
- Weather corrections
- Car usage
- Rolling/traction split
- Road category
- Environment control

Real environment
- Real layout
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Human perception & annoyance
- Sonie, harshness, loudness

dbA

Homologation
Declaration

Regulatory Source control

ISO 11819

2002/49/CE

Weather cond. & corr.
Noise perception in urban environment

Source: Bruiparif 2019
The types of noise considered as the most annoying among transport noise

Annoying noise sources

IDF

- 2 wheelers
- Horns
- Passenger car
- Truck & bus
- Aircraft
- Railway
- Other

0% 50% 100%

Région Ile-de-France

Paris

Île-de-France Métropole hors Paris

Île-de-France Métropole du Grand Paris

Hors Île-de-France Métropole du Grand Paris

Île-de-France Haut-de-Seine

Île-de-France Saint-Denis

Île-de-France Val-de-Marne

Île-de-France Val d'Oise

Île-de-France Essonne

Île-de-France Seine-et-Marne

Île-de-France Yvelines

BRUITPARIF
Noise annoyance update: The after lockdown for COVID Impact

COVID did provide an unprecedented real life masking experiment / below are BRUIPARIF data for « Ile de France » on perceived annoyance, after lockdown upon economical restart, a survey was conducted:

49% of the annoyance is linked to road traffic in which passenger cars represents 25% of the annoyance => 13% of total annoyance linked to car traffics
The world we are stepping into

- **Smart cities**: connectivity, collaborative systems, traffic management, big data...
- Health and safety, quality of life is priority
- Hazardous Pollution monitoring (noise, radio, air quality…)
- Cheap sensors
Distributed instruments, participative maps...

A sound level meter in every pocket?
Noise measurement in urban environment

Source: Bruiparif 2019
Example of smart noise monitoring

Noise « peak events » in a Paris boulevard in 2016 (source : Bruiparif), and their contribution to LAeq

80% of events are Horns, Sirens, 2 wheelers and trucks

2/3 of noise level is made by events
Contribution of noise peaks to LAEQ over 1 month in 90 measurement points in Paris.
The noise radar

We can foresee a large spread of such technologies financed by fines. Meaning also that detailed soundscape data are available, and generalized noise event participation precise measurement.
We already know that R51 72 or 74 dBA Vehicles in pass by are not major sources today.

**Results for rue Frémicourt, Paris 15**

**High noise peaks with $\text{L}_\text{Amax} \geq 80 \text{ dB(A)}$ (non-respect of homologation standards)**
- Represent less than 2% of the number of peaks due to vehicles
- But are responsible for 37% (week days) of road noise

**Low noise peaks with $\text{L}_\text{Amax} < 70 \text{ dB(A)}$ (respect of ECE R51 regulation for Passengers cars)**
- Represent 2/3 of the number of peaks due to vehicles
- But are responsible for only 1/4 of road noise
Car noise regulation & Environmental noise regulation

CE Directives: 2002/49/CE
In 2024 in France:

Number of trucks $\times L_{\text{urban\ trucks}} >$ Number of cars $\times L_{\text{urban\ of\ cars}}$
Trying to link R 51 Homologation with CNOSSOS for M1 vehicles is Homologation representative of real usage? Of real modeling?

<table>
<thead>
<tr>
<th>Tires</th>
<th>Vehicle operation</th>
<th>External condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard (no stud)</td>
<td>Accelerated</td>
<td>Iso Track</td>
</tr>
<tr>
<td></td>
<td>(f(PMR))</td>
<td>Flat</td>
</tr>
<tr>
<td></td>
<td>Constant speed</td>
<td>Flat or Slope</td>
</tr>
<tr>
<td></td>
<td>(50 kPH)</td>
<td>Temperature correction</td>
</tr>
<tr>
<td></td>
<td>All accelerations</td>
<td>R1/R2/R3</td>
</tr>
<tr>
<td></td>
<td>All Constant speed</td>
<td>R1/R2/R3</td>
</tr>
<tr>
<td></td>
<td>All Constant speed</td>
<td>Temperature correction</td>
</tr>
</tbody>
</table>

Link?

Very weak or no connection between vehicle homologation and source description
Yet good correlation between computed maps and measurements

50 Kph point

Avg Iso = R1 ??

Flat

Strong influence on tire noise!
Possible consequences of the global misalignment

Everyone (Car makers and public policies) worked to comply, but citizen complains
And regulations on source becomes tougher for no real effect

Pass by noise regulation

Strategic noise maps

Real soundscape

Public authorities

More stringent limits

Public policies, speed, barriers...

Complaints

Cost, safety tradeoffs

Compliance to R051

World Health Organization
Deep dive: Technical aspects at car source levels

Main impacts of future PBN
Technical insight for future Pass-By Noise Regulation (R051):
Tire/road interaction contribution (for the full PBN test)

➔ 2020 : 72 dB (Phase 1)
  ≈25% from Tire/Road contact
  ≈90% from Tire/Road contact

➔ 2024 : 70 dB (Phase 2)
  ≈50% from Tire/Road contact
  ≈90% from Tire/Road contact

➔ 2024 : 68 dB (Phase 3)
  ≈70% from Tire/Road contact
  ≈90% from Tire/Road contact

(on ISO Tracks in homologation conditions for mean vehicle & mean tire)

Source: Renault, 2020
There is a hard limit to tire/road interaction noise

⇒ Tradeoff with safety (wet grip, braking...) and emission (C02, Particles)
Tire main tradeoff for noise is Safety

Slick tire is the asymptote for the noise coming from tire sculpture

Void ratio is essential for safety (wet braking and aquaplaning)
Car noise on real world roads
EXAMPLES OF ROAD IMPROVEMENTS FOLLOWED BY BRUITPARIF

Installation of anti-noise road surfaces

Parisian ring road Pte de Vincennes

Change of road surface
Max. speed limited to 70km/h

+0.66dB(A) per year
Road noise assessment from vehicles compliant to future PBN requirements on real roads
Road surface & wear impact

Source: CEREMA / DEUFRA BASE data

Sigma (road type + state) = 4.2 dB
ISO track = best road then 50% chance that real world = +8 dB
Results: projected levels for nominal vehicle @ Constant Rolling Speed

Levels are dropping of 1.25 dB on ISO track for each regulation step, And about 1 dB for all kind of roads (at 50 kph steady speed) / Source: WG SIA 2020
Assessment of impact of compliant vehicles on real roads @ constant rolling speed

Best tire, nominal vehicle (-2.5 ; -5 dB)
Gain on ISO track: 1.2 dB/step
Gain on all roads ≈ 1 dB/step

dependancy to tire/road interaction noise

Best tire, improved vehicle (-5 ; -8dB)
Gain on ISO track: 1.5 dB – 1.2dB/step
Gain on all roads ≈ 1 dB/step

dependancy to tire/road interaction noise

Rolling noise dependancy becomes so high that even huge efforts on vehicle build have no impact on real roads
Global efficiency & asymptotic behavior:
Going below 68 dB is useless
Conclusions : real road assessments

Rolling noise is so dominant that
1) improving other sources has no effect when tire/road is at its best =>
   4 dB improvement of Lurban would lead to 2dB reduction on
   reference roads (-37%) way below road variability (13dB)
2) tire and vehicle already reduced and are now cin the asymptote
3) Working on road surface has a much better efficiency (-6dB) (-75%)
   (see report of Bruiparif on Periphérique)