TYRES & ROAD TRAFFIC NOISE: WHERE IS THE POTENTIAL?

September 13th and 14th 2021
AGENDA
WHERE WE SHOULD LOOK FOR TYRE AND ROAD TRAFFIC NOISE IMPROVEMENTS

- Noise regulations evolutions vehicles, tyres, roads
- Tyre vs Vehicle: approach about UN R117 & R51
- Current EU market status

- Noise generation: from Road to Tyre & Vehicle
- Meaning of decibel

- Trade-offs
- The central role of measurements accuracy

- Seeking for harvesting noise reductions:
  Where is the problem
  What can be effective

Tyre industry:
- aware of the issue
- aware of regulatory framework
- committed to contribute

- Vision and proposal for real-world time effective noise improvements, while safeguarding other ambitious sustainability and safety priorities.
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Tyre Industry

➢ recognizes the need to contribute to the reduction of noise pollution
  ▪ environmental noise is an important problem for the society to be addressed through effective and efficient actions also including transport noise measures;
  ▪ there is a need to focus on time-efficient and cost efficient measures addressing the real-world road transport noise

➢ is aware of the legal obligations of the EU
  ▪ there is legal obligation of the EU Commission for a detailed study on sound level limits by 1 July 2021 and to then submit, as appropriate, a legislative proposal* as well as of the noise ambition included within the EC Zero Pollution Action Plan communication**

➢ is aware of the recent and ongoing studies
  ▪ investigating the current sound emission levels of M and N category vehicles to propose possible improved sound level limits for the next phases of the Regulation (EU) No 540/2014 in the coming years. EC preliminary direction towards most efficient measures*** for noise negative health effects mitigation:
    - limit tightening after phase 3 [R51]
    - more severe ASEP [R51]
    - additional 2 stages tyre limits (2x2dB) [R117]

This document is aiming at analysing technical facts, providing industry views on the EC preliminary direction as well as seeking for feasible proposals.
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- Context
- History & Current Status
- Margin for Improving
- Potential in the road mobility compartment

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The meaning of Decibel

The acoustic intensity is a ratio between the sound emitted by a source and the reference human audibility.

This acoustic intensity is usually written in decibel (dB) - a logarithmic, not linear, scale.

- Reducing noise by 3 dB is the same as **halving (!) the noise intensity**.
- If one car emits 70 dB, for instance, the sum of the sound emitted by the two cars is not 140 dB but 73 dB.

=> Thus, noise reductions expressed in dB, may appear limited, they have a major impact on sound intensity and the product design.
Noise is the result of vehicle, tyre and road interaction.

**Generation mechanism of tyre-road noise (C1 tyres)**

**TYRE**
Construction, cross-section shape, Material, Pattern design

- Noise generation
  Tyre / road interaction generates vibrations and air pressure variations in the contact area

- Noise transmission
  Transmission of the vibrations from the contact area to the tyre body.

**VEHICLE**
Acoustic absorption

- Noise propagation
  Dynamic air pressure variations are propagating into the environment as airborne sound

**ROAD**
Texture, roughness, porosity, acoustic absorption, ...

1. **Tyre-Road contact**
   › Premium tyre profiles are constantly being further optimized to reduce excitation, with the constraints of the performances trade offs.
   › On the road side, the texture design of the road surface influences the vibration excitation of the tyre tread.

2. **Vibration transmission**
   › This can be improved by introducing materials with higher damping, which would have a negative effect on rolling resistance and thus CO2 emissions

3. **Noise propagation**
   › After the airborne noise has been emitted, it can only be counteracted with sound-absorbing materials.
   › In modern vehicles, the wheel arches and the underbody are already optimized in this regard.
   › Porous and sound-absorbing road surfaces and other passive measures in the immediate vicinity of the road and on buildings are a key option.

4. **Human sensitivity**
   › To be addressed according to the key critical impacts: e.g. noise peaks
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The tyre industry has made important progress and reduced noise by up to 5 dB, more than halving sound emissions.

- 3 dB reduction corresponds to reduce acoustic intensity by a factor 2
- 5 dB reduction corresponds to reduce the acoustic intensity by 3

In addition to R117, tyres are also indirectly regulated by R51
HISTORY & STATUS

Where we are: current status of Tyre industry for PBN and other performances

Some studies (e.g. Phenomena) are claiming that there is margin for noise limits improvements with no trade-offs.

Example for C1 tyres (aggregated data for 2019-2020)

Only by label comparison there are no apparent trade-offs, but in reality:

- target conflicts do exist, especially amongst performances not visible on the label: see next slides
- the above data are highly affected by noise measurement uncertainties
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There are market groups with significant noise conflicts, but these conflicts differ per tire size, segment, niche market position & individual tire design strategy. Overall 80% of analysed groups show strong target conflicts of noise vs. other performances.
Trade offs: are largely linked to currently non-regulated performances, even if some of these are going to be regulated.

ETRTO-UTAC study presented at UN GRBP:
We are close to slick tyres noise potential
The European Tyre Label is a good indicator of basic tyre performance. However, both tyre safety and comfort also depend on other performances in all conditions and for their entire lifespan. Many parameters are not covered by the label: wet-weather handling, dry braking performance, high-speed stability, aquaplaning, wear resistance, comfort and interior noise...
Trade offs linked to non-regulated performances are being overlooked by the majority of studies

› Assessments of potential noise improvements by the tyre are based just on evaluations of label databases, which refer only to regulated performances.

› Referring to available data-sets and not collecting new measurement data vs non-regulated performances.

› Often referring to outdated data stets.

› Effect of quiet roads is mentioned, but often underrated due to assumed high cost (not quantified in detail). A quiet road will benefit immediately on all the vehicles without the need for waiting for the market renovation.

Example: Phenomena study

Based on currently available data in tyre databases (Dutch VACO database and Swiss Database), reductions of 2dB from 2022 and 2dB in 2026 seem to be feasible. From the viewpoint of impact, the most numerous tyre groups and those with the largest mileage would be most beneficial for tighter limits.

2-4 dB in the tyre noise, depending on road surface, vehicle type and speed and tyre size. The potential is highest for smooth, absorptive and well maintained road surfaces. Noise reduction can be calculated for different road surfaces, such as in the

According to a Dutch tyre database\textsuperscript{[7]}, around 20% of car tyres on the market in 2018 were 4 dB below the highest level of 72 dB(A). This would need to increase significantly in the coming years to around 80% to take effect in overall traffic noise levels. The potential is strongest if EU tyre noise limits are tightened, as previously proposed in the GRB (UNECE)\textsuperscript{[24]}

Table 7.1 Scenarios with a single noise solution for road traffic noise. In all cases a final situation in 2035 (or 2024 for scenario B) is specified; for intermediate years, linear interpolation is applied

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - quiet roads</td>
<td>The fraction of roads with a quiet surface are increased for road types 2-4. The length percentages are 22.3% in 2035, which is a factor of 4.5 higher than the baseline value of 5%</td>
</tr>
<tr>
<td>B - quiet tyres</td>
<td>The tyre labels for the three vehicle types are gradually decreased from 70/72/75 (baseline to 60/65/60) in the period 2020-2024 and remain constant after 2024</td>
</tr>
</tbody>
</table>

Trade offs are not visible in assessments when based only on label performances
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Anyhow significant margins for improving do exist when analysing Noise Measurement Uncertainty Concept

With the current test method the variability could allow to homologate a noisier tyre (e.g. 73 dB for a threshold of 72) → Right part of the curve

Once new method will be available, with lower uncertainty, this will not be possible anymore. → tyres “in the range of more than 2 dB above the current limits”, which today can benefit from the variability, cannot be homologated anymore.
Measurement Uncertainty
Quantifying the potential

With current measurements uncertainty statistically there is a probability 1 out of 3 tyres is approved as compliant with the limit although its noise emissions are actually above the limits.

Assuming a strong improvement of measurement uncertainties (standard deviation from current 1.17 dB(A) to 0.7-0.5 dB(A)), the proportion of tyres in this category will be reduced to potentially up to 10%, so that tyres 2dB(A) above the threshold will be eliminated.

Global assumption: gaussian uncertainties distribution, random tyre test on different tracks
Each line is 100%: the distribution of dB across that size

Further market surveillance based on current method can anyhow produce noise improvements, and even more once new more accurate methods will be in place.

*Values depending on database update status
Proposed roadmap to reduce uncertainty in R117

- 2021: Introduction of indoor test for R117
  - ± 2.5 dB(A)
- 2022: ± 2 dB(A)
- 2023: ± 1.5 dB(A)
- 2024: ± 1 dB(A)
- 2025: ± 0.5 dB(A)
- 2026: ± 0.5 dB(A)
- 2027: ± 0.4 dB(A)
- 2028: ± 0.9 dB(A)

ISO 20908

R117 EiF

Unique outdoor and indoor reference test surface

Tyre industry is investigating further methodologies to accelerate this roadmap
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Exploring the potential for transport noise reduction
where to act

Current regulatory approach

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Tire</th>
<th>Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>separately optimized for</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- noise |
- safety |
- environmental impact |
| separately optimized for |
- noise |
- safety |
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| separately optimized for |
- noise |
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UN R51 / Reg.(EU) 540/2014 & Reg.(EU) 2019/839
Noise reduction with lowest trade-off on other vehicle performances

UN R117 / Reg.(EU) 2019/2144
Noise reduction with lowest trade-off on other tire performances

NONE

Holistic approach

<table>
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<tr>
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<tbody>
<tr>
<td>overall optimized for</td>
</tr>
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</table>
- safety |
- environmental impact |

Can balanced requirements deliver even higher noise reduction with lowest trade-off on overall system performances?
The properties of the road surface have a major influence on the generation of the rolling noise.

The interaction of the tyre pattern with the road and thus the vibration excitation of the tyre varies due to the design of the road surface roughness, porosity and many other parameters of the road surface.

For the same tyre there are noise differences evaluated in different studies between 5 and 12 dB on public roads.

Research into noise-optimized road surfaces, not impacting roads safety and durability, shall be one of the key objectives with regard to a further reduction in traffic noise.

The ideal road surface is porous and smooth, but like with tyres, there are also conflicting goals here.
Focus on effects: Local peaks disturbance

$L_{den}$ does not consider local peaks, which have a strong impact.

- Local peaks represent a major part of local (not only traffic) sound emission.
- However $L_{den}$ calculation does not consider them: regulatory limits on tyres and vehicles do not address the major disturbance as it is measured and felt by citizen.

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The Noise Peaks’ Issue

Results for rue Frémicourt, Paris 15

High noise peaks with $L_{Amax} > 80$ dB(A) (non-respect of homologation standards)
Represents 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 $L_{Amax} < 70$ dB(A) (respect of ECE R21 regulation for Passengers cars)
Represent 2/3 of the number of peaks due to vehicles
But are responsible for only 1/6 of road noise

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The Noise Peak’s Issue

Case study: city center road (rue des haudriettes, Paris 3e)

556 noise peaks per day (253 high noise peaks with $L_{Amax} > 80$ dB(A))

Main sources responsible for peaks (in number):
- horns (37%),
- two-wheelers (29%),
- trucks (24%)

Contribution of noise peaks in ambient noise: 58%

Vehicles and tyres non emergent sound only taken in consideration

Main local peaks sources are
- Horns and sirens
- 2 wheels
- Trucks

Tyres are not a part of these peaks
Focus on effects: Local peaks disturbance

*Lden does not consider local peaks, which have a strong impact*

Addressing tyre noise limits will not address the major disturbances that would remain out of scope. Taking into account the masking effect of the peak, the progress made on threshold will not be perceived by citizens.
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1. **Measurement Uncertainty:** there is a potential to address a very significant part of the market that may result in not-compliant tyres if tested with a more accurate method and thus requiring re-design for noise reduction and improvements. **Industry is working on very clear deadlines to achieve these improvements and the relevant results.**

2. **Trade offs:** non regulated performances are in clear trade off with noise performance and some of these performances are going to be regulated

   Hydroplaning $\rightarrow$ Wet grip @ worn
   Wear $\leftarrow$ Abrasion

   There is a clearly scheduled industry commitment on the improvement of other performances addressing climate and safety while continuing working on the improvement of traffic sound emission by drastically reducing the measurement uncertainty
## Detailed plan on noise measurement uncertainty

<table>
<thead>
<tr>
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<th>Event</th>
<th>Description</th>
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<tr>
<td>2021</td>
<td>ISO 20908</td>
<td>Introduction of indoor test for R117</td>
</tr>
<tr>
<td>2022</td>
<td>R117 revision short term</td>
<td></td>
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<tr>
<td>2023</td>
<td></td>
<td>R117 amendment Improvement of uncertainty factors within R117</td>
</tr>
<tr>
<td>2023</td>
<td>Full ISO 10844 revision</td>
<td>Uniform outdoor and indoor reference test surface</td>
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<tr>
<td>2024</td>
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<td>2025</td>
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<td>2027</td>
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</table>

### Starting with an improvement of measurement uncertainties
- Planning and progress of test method development
- Significant improvement in measurement uncertainty is connected to introductions of ISO 20908 and especially a completely revised concept with a worldwide uniform test track surface within ISO 10844

Tyre industry supports the assessment of methodologies necessary to evaluate the whole ecosystem, e.g. road surface, peak noise, traffic regulations, etc. and stimulate its improvement regarding noise
- Launch project calls on road/tyre interaction optimization for noise
- Develop road labelling approach
Additional Questions
Thank you
Measurement Uncertainty starting from the perspective of a known “true” measurement value

Example:
Tire noise limit Reg.117 = 72 dB
Tire “true” value = 73 dB

By measurement uncertainty reduction probability to homologate tire out of the limits is strongly reduced.
Example: actual design trade-offs

Trade-offs are fully visible when analysing non-regulated tyre performances, that by the way, are part of the forthcoming regulatory approach supported by tyre industry.