Dimensionnement acoustique des lignes d’admission et échappement chez PSA
Gamma Technologies User Group: 17 et 18 Mai 2017
1

CONTEXT AND ISSUES
Context and issues

- Why study vehicle acoustics?
  - Inner comfort
  - Vehicle approval
Context and issues: inner comfort

- **Why study interior noise?**
  - Perceived quality
  - Limited level for specific countries (ex: Russia)
Context and issues: inner comfort

- Main acoustical sources for interior noise

  - Engine
  - Intake noise
  - Tires
  - Exhaust line
  - Tailpipe noise
  - Vehicle structure
  - Aeroacoustical sources (e.g., windshield, etc.)
Context and issues: vehicle approval

- Vehicle approval:
  - Limited pass-by noise
  - Evolution of maximal authorized level

<table>
<thead>
<tr>
<th>Max. level</th>
<th>“New type” vehicle</th>
<th>“all type” vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 dB(A)</td>
<td>07/2016</td>
<td>n/a</td>
</tr>
<tr>
<td>70 dB(A)</td>
<td>07/2020</td>
<td>07/2022</td>
</tr>
<tr>
<td>68 dB(A)</td>
<td>07/2024</td>
<td>07/2026</td>
</tr>
</tbody>
</table>
Context and issues: vehicle approval

- Main acoustical sources for pass-by noise

- Tail pipe noise
- Engine + intake noise
- Tires
2

STUDY PERIMETER
Study perimeter: intake system
Study perimeter: exhaust system
3

CALCULATION USAGE
Calculation usage

- Sort line hypothesis
- Estimate required volumes
- Check / compare supplier proposal
4

STUDIED PARAMETERS
### Studied parameters

<table>
<thead>
<tr>
<th>Pre-Development</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Order:</td>
<td>Calculation + Measurement</td>
</tr>
<tr>
<td>Overall level:</td>
<td>Calculation + Measurement</td>
</tr>
<tr>
<td>Emissivity:</td>
<td>Measurement</td>
</tr>
<tr>
<td>Subjective noise: (Harshness, etc.)</td>
<td>Measurement</td>
</tr>
</tbody>
</table>
5

CALCULATION PROCESS
Calculation process: intake noise

- **Input Data:**
  - CAO
  - TL Measurement
  - 3D Calculation / Measured backpressure
  - GT-Power Engine model

- **Process:**
  - CAO → 1D Model → 1D TL Calculation → OK?
  - CAO → 3D Model → 3D TL Calculation → 1D TL Calculation → OK?
  - TL Measurement → Backpressure coefficient settings → Backpressure 1D calculation → OK?
  - Backpressure 3D calculation / measurement → GT-Power engine model → Intake noise
Calculation process: tailpipe noise

- **Input Data:**
  - CAO
  - Backpressure 3D calculation / measurement
  - Thermal exchange feedback
  - GT-Power engine model
  - Flow noise efficiency feedback

- **Process:**
5

CALCULATION TOOLS
Calculation tools: intake noise

- **GT-Power**
- **GT**
- **Actran**
- **Intake noise**
- **Backpressure**
- **Fire Fluent**
- **Fluent ANSYS**
- **TL**
Calculation tools: tailpipe noise

- GT-Power
- GT
- Fire
- Fluent
- Excel

- Tailpipe noise: Engine order
- Tailpipe noise: flownoise
- Backpressure
6

GT-POWER ENGINE MODEL
GT-Power engine model

- Intake system: low pressure
- Turbocharger model
- Exhaust system
- Performance optimized engine
- Injection model
- Valve train model
- Cylinder head thermal model
- Combustion model
- Microphone model

Components:
- Intake system: high pressure
- Turbocharger model
- Exhaust system
- Performance optimized engine
- Injection model
- Valve train model
- Cylinder head thermal model
- Combustion model
- Microphone model
GT-Power engine model: volumes modeling
RESULTS FEEDBACK
Results feedback

- **Shape: average / level: average**
  - Potentially remarkable magnitude differences
  - Potentially non marked emergences
  - Correlation may change with the microphone position
Results feedback

- **Shape: good/ level: good**
  - Good order of magnitude for maximum level
  - Shape of the calculated curve coherent with measurement
  - Potential frequency shifting
8

REMAINING IMPROVEMENTS
Remaining improvements

- **Engine orders:**
  - Raw results correction according to existing feedback
  - GT-Power engine model to improve
    - Turbocharger model reliability
    - Valve train model reliability
  - Calculation method to improve
    - Fiber influence
    - Engine functioning condition

Comment: Measurement process to improve
Remaining improvements

- Flow noise:
  - Flow noise efficiency extracted from database
  - 3D Calculation method to develop

- Harshness:
  - Predicting model to develop

- Thermal model:
  - Exhaust thermal model to improve

- Backpressure:
  - Backpressure distribution to improve when no measurement is available
Thank You!

QUESTIONS
APPENDIX
Appendix: Backpressure Calculation

- Representative of a steady flow bench
Appendix: Transmission Loss Calculation