STUDY ON EURO 5 SOUND LEVEL LIMITS OF L-CATEGORY VEHICLES

66th GRB meeting, 04.-06.09.2017

On behalf of the European Commission
GENERAL INFORMATION

› Tender ID:
   › Title: Study on Euro 5 sound level limits of L-category vehicles
   › Tender No: 524/PP/GRO/IMA/16/1131/9316
   › Contract No: SI2.736346 of the Consortium with the European Commission - DG-GROW

› Consortium performing the work:
   › EMISIA - Greece
   › TNO - The Netherlands
   › Ricardo Deutschland GmbH - Germany
   › Heinz Steven Data Analysis and Consultancy (HSDAC) - Germany
Investigate the potential for new sound limits of L-category vehicles at Euro 5 step and make a justified proposal, taking into account:

- Citizens’ needs and stakeholders interest (feedback gathering)
- Evolution of sound levels of road vehicles (actual vehicle testing)
- Technical and economic feasibility in medium term (cost-benefit analysis)

Any new sound limits to be accompanied by an appropriate timeframe for their introduction
PROJECT TASKS AND TIME PLAN

1. Task 1: Estimate of sound level limits for all L-categories (10.16 – 01.17)
   a) Feedback gathering – stakeholder survey
   b) Literature review

2. Task 2: Verification of sound level limits (01.17 – 04.17)
   a) Actual vehicle testing – sound measurements
   b) Processing of results

3. Task 3: Cost-benefit analysis (03.17 – 09.17)
   a) Input data, scenarios, first results
   b) Improvements, final CBA results

4. Task 4: Validation tests (03.17 – 06.17)
   a) Additional vehicle testing – sound measurements
   b) Noise Source Ranking (NSR)

5. Task 5: Proposal for limit values and reporting (07.17 – 10.17)
   Final sound limits proposed by the study and recommendations

EMISIA, HSDAC
Completed

RICARDO
Completed

TNO
In progress – Input data, methodology

RICARDO
Completed

CONSORTIUM
PROJECT DELIVERABLES

› 1st Intermediate Report (June 2017) – approved by EC

Contents: Detailed presentation of

› Method and outcome of Task 1 (stakeholder survey + literature review)

› Work and results from Tasks 2, 4 (vehicle testing)

› CBA methodology and input data (currently under work)

› Final report and recommendations (October 2017)

› Final results from the CBA, refinements and improvements

› Final proposal for the new sound limit values and recommendations
SUMMARY OF SURVEY AND LIT. REVIEW

Approach:

- Technical questionnaire to stakeholders (manufacturers, authorities, concerned citizens' associations, environmental organizations, etc.) to collect responses

- Objective to make first proposal estimate of new Euro 5 sound level limits

Main outcome:

- Potential room for improvements (lower sound limits) with technical measures
- Already vehicles type-approved with 2 dB or lower levels than limit
- 2 dB(A) considered moderate feasible reduction [opinions range: 0 to >5 dB(A)]
TASK 2, TESTING OBJECTIVES

The objective of including testing of sound levels in the study:

- Establish **current sound levels** of state of the art vehicles
- Assess the **contribution of various sources** (vehicle components) to the sound level (noise source ranking with successive physical masking of the different sound sources)
- Investigate the current **sound emissions control technology** and the technical feasibility for improvement of sound level performance

Selection of vehicles:

- Recent **homologation** certificates (no more than 2-3 years)
- **Type approval** levels under or on the current limit
- **Availability** in suitable condition for testing within the current rental market

- Vehicles **rented** and tested **unmodified** (brand new vehicles or with low mileage)
VEHICLES TESTING

- Testing on homologated tracks in Spain and Germany
- Vehicles tested according to UN Regulation 63, Regulation 41-04 and Regulation 9, depending on respective vehicle categories
CONCLUSIONS FROM MEASUREMENTS

› Vehicles comply with their COP criteria

› Vehicle-specific behaviour:

   › All three mopeds 1 dB(A) below current limit,
   › Two of the four L3e vehicles at or close to the current TA limit,
   › Two of the four L3e vehicles and one L5e-B vehicle 4-5 dB(A) below current TA limit,
   › The L5e-A vehicle at the current TA limit,
   › The L6e-BP (mini-car) 14.5 dB(A) below current TA limit
   › The L7e-B1 (ATV) at current COP limit

› Reduction in sound limits will have different implications for different vehicle sub-categories

   › Limit values for L5e-B and L6e-BP should be adjusted to the state of the art (4 or 8 dB reduction respectively would not require new technology measures)

   › The feasibility of a similar reduction for L3e would be debatable.
VALIDATION: NOISE SOURCE RANKING (NSR)

- Sound level is considered as the joint contribution of 4 different sub-systems: Exhaust, Intake, Engine, Driveline

- Sub-systems covered for testing with heavy and effective acoustic damping material or muffled with additional “oversized” infinite mufflers (for intake and exhaust)

- These mufflers are not production representative but purposely reduce the exhaust and intake orifices sound emission

- Each configuration is separately measured on pass-by measurement set up on both accelerated and cruise conditions

- The comparison of all the various runs shows the contribution of the corresponding non-muffled subsystems

Tested configurations:

**Scooter:**

1. Original configuration
2. CVT suppressed
3. CVT and engine suppressed
4. CVT, Engine and Intake suppressed
5. CVT, engine, intake and exhaust suppressed

**Motorcycle & ATV:**

1. Original configuration
2. Drive suppressed
3. Drive and engine suppressed
4. Drive, Engine and Intake suppressed
5. Drive, engine, intake and exhaust suppressed
NSR RESULTS MOTORCYCLE 800cc PMR>50

Maximum pass-by area

Contributions of:
- Exhaust
- Intake
- Engine
- Driveline

Baseline sound level in original configuration, also equivalent to the total of all contributions

- Exhaust dominant over transients, engine and driveline at constant speed
## NSR TESTING CONCLUSIONS

<table>
<thead>
<tr>
<th>Category</th>
<th>Test Concerns</th>
<th>Main contributors to sound levels</th>
<th>Technology to achieve lower levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1e-B, L2</td>
<td>WOT</td>
<td>Exhaust main contributor, lower limit than other categories leaves less margin for reductions</td>
<td>Mostly exhaust but CVT as well</td>
</tr>
<tr>
<td>L3e, CVT</td>
<td>WOT, CRS</td>
<td>Exhaust and driveline are all important kp: power specific weighing of CRS/WOT</td>
<td>Exhaust sound attenuation, significant CVT attenuation necessary</td>
</tr>
<tr>
<td>L3e, manual</td>
<td>WOT, CRS</td>
<td>All components important CRS: intake, engine, driveline WOT: exhaust kp: power specific weighing of CRS/WOT</td>
<td>Vehicle specific but all four categories need to be considered.</td>
</tr>
<tr>
<td>L5e-A, L7e-B</td>
<td>WOT</td>
<td>No CRS contribution, hence exhaust most important</td>
<td>Exhaust sound attenuation Driveline in L7e-B</td>
</tr>
<tr>
<td>L5e-B, L6e-B, L7e-C</td>
<td>WOT</td>
<td>Vehicle specific, but definitely exhaust due to WOT test</td>
<td>Engine, exhaust, driveline: Better encapsulation possible</td>
</tr>
</tbody>
</table>
COST-BENEFIT ANALYSIS (CBA)

The objective of performing CBA is to investigate the feasibility and relevance of possible new (lower) sound level limits for L-category vehicles.

The effectiveness of introducing lower limits depends on:

- better enforcement = less excessive L-category vehicle noise due to illegal exhausts, tampering
- the relation between the limits and real world sound levels, especially the $L_{\text{WOT}}$ levels on roads under acceleration (also: cycle bypassing for the test method)
- new (lower) sound limits of other vehicles gradually taking effect
**CBA METHODOLOGY**

**Benefits**

- Road situation
  - Avg. speed
  - Driving condition intermitt./constant
- L-cat and other limits
  - Vehicle type
  - Vehicle modifications and wear
- Fleet and activity growth
  - Traffic flow including other vehicles
    - Average receiver distance, propagation for each road type
  - Total road length and dwelling density per road type
- Amenity benefits €/dB/dwelling/year
- Health benefits €/dB/dwelling/year

**Costs**

- Manufacturers
  - Extra R&D costs €/year
- Authorities
  - Extra enforcement costs €/year
  - Extra testing costs €/year
  - Extra production costs €/year

**Directive 2002/49/EC:**

**Long term average sound levels at the facade**

- **L_{DEN}**: Day Evening Night Level weighted 12/4/8 h
- **L_{Night}**: Night level, 8 h

**Total benefits**
**BENEFITS**

- Use of $L_{DEN}$ (average) noise levels at the dwelling facade to assess noise reductions, which can be **monetised**

- $L_{DEN}$ level calculated with EU traffic noise model CNOSSOS, taking **representative road** types and sections into account

**Valuation:**

- **Amenity** (willingness to pay): € 29.90 / dB reduction / dwelling / annum based on EU paper 2002
- **Health** (only heart disease): € 17.60 / dB reduction / dwelling / annum based on TNO and UK estimates used for traffic noise

Alternative approach would be to use assessment of **single events**, $L_{Amax}$ (currently under investigation)
COSTS

- **Industry** costs due to additional R&D, manufacturing and testing  
  (cost = price – tax – markup)

- **Enforcement** costs for authorities and traffic police

- Cost approach based on *previous approach* (i.e. L-Euro 5 emission study):
  - Information received from industry
  - Consortium assessment of technological needs to achieve lower limits
BENEFIT TO COST RATIO - NET PRESENT VALUE

Benefit to cost ratio =
Accumulated benefits over 20 year period
Accumulated costs over 20 year period

Net present value =
discounted value of benefits minus the discounted value of costs

Discount rate = 4% (takes future value into account)

Interest rate = 1% (takes growth and inflation into account)
CBA SCENARIOS

› Horizon: 2020 – 2040

› 1) Baseline scenario: no change to L-category limits

› 2) Reduced limits: on average -2 dB limit reduction

   Exact limit change depends on L-subcategory considered

› 3) Ambitious scenario: on average -5 dB limit reduction

   Exact limit change depends on L-subcategory considered

   Scenario aims at showing max potential benefit if other conditions are met
SCENARIO CONDITIONS

› Market growth (as in “L-cat Euro 5 effect study” project)
   a) baseline: ‘business as usual’ after an initial sales rebound, shrinkage of mopeds sector, slow increase of motorcycles fleet
   b) high growth: increased number of registrations and fleet for motorcycles reflecting a vibrant economy, slower reduction of mopeds fleet

› Traffic “background” noise levels
   a) baseline: current mean traffic noise levels despite tighter limits due to traffic growth
   b) reduction: average traffic noise levels reduced by 4 dB in 2040 due to lower limits for other vehicles, as in EU Regulation (EU) No 540/2014

› Enforcement and ‘off-cycle’ sound levels
   a) baseline: moderate enforcement, use of automatically controlled exhaust flaps
   b) stringent: stringent enforcement, control of off-cycle sound levels
SITUATIONS IN WHICH $L_{DEN}$ IS REDUCED

- **Accelerating traffic only**

- **Northern EU $L_{DEN}$ effect:**
  - Touring routes, mainly motorcycles
  - Residential roads, mainly mopeds
  - Main roads, mopeds and motorcycles
  - 20% of the year (touring season, weekends+holidays)

- **Southern EU $L_{DEN}$ effect:**
  - Residential, main, arterial and rural roads
  - Both mopeds and motorcycles
  - 50% of the year (actual use)
NEXT STEPS

› September – October 2017:
   › Results and conclusions of CBA
   › Limit values proposed and justification
   › Discussion on boundary conditions for ASEP
   › Final report
THANK YOU FOR YOUR ATTENTION