

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

66th GRB meeting, 04.-06.09.2017



Data Analysis
and
Consultancy

TNO innovation
for life



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



PROJECT OBJECTIVES

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

EMISIA, HSDAC
Completed

2. Task 2: Verification of sound level limits (01.17 – 04.17)

- a) Actual vehicle testing – sound measurements
- b) Processing of results

RICARDO
Completed

3. Task 3: Cost-benefit analysis (03.17 – 09.17)

- a) Input data, scenarios, first results
- b) Improvements, final CBA results

TNO
In progress – Input
data, methodology

4. Task 4: Validation tests (03.17 – 06.17)

- a) Additional vehicle testing – sound measurements
- b) Noise Source Ranking (NSR)

RICARDO
Completed

5. Task 5: Proposal for limit values and reporting (07.17 – 10.17)

Final sound limits proposed by the study and recommendations

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)]



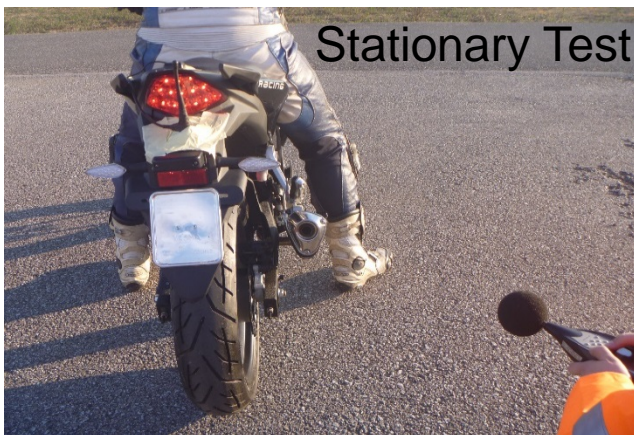
TASK 2, TESTING OBJECTIVES

- › **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 "over-sized" 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

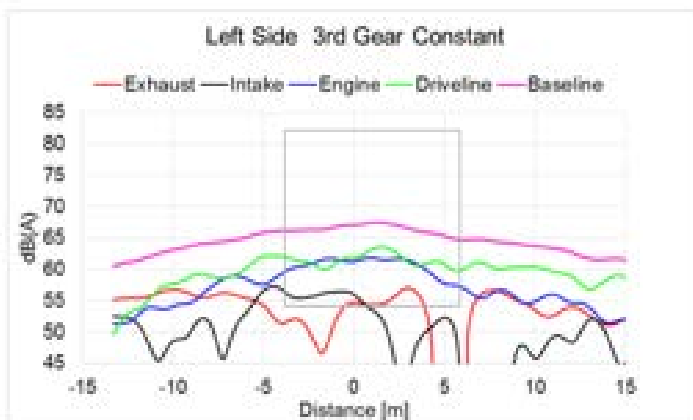
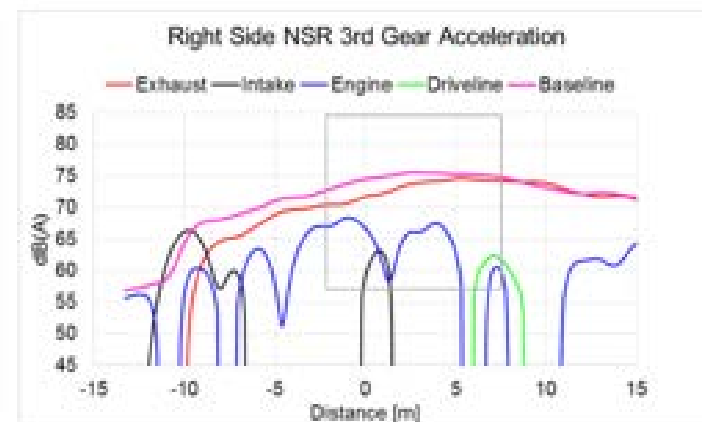
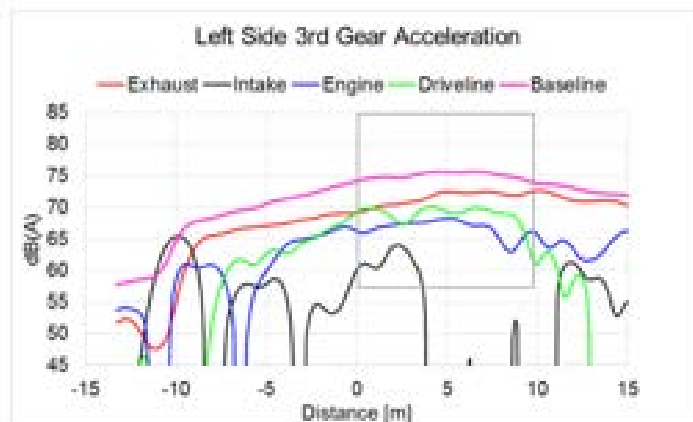


NSR RESULTS MOTORCYCLE 800cc PMR>50

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

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



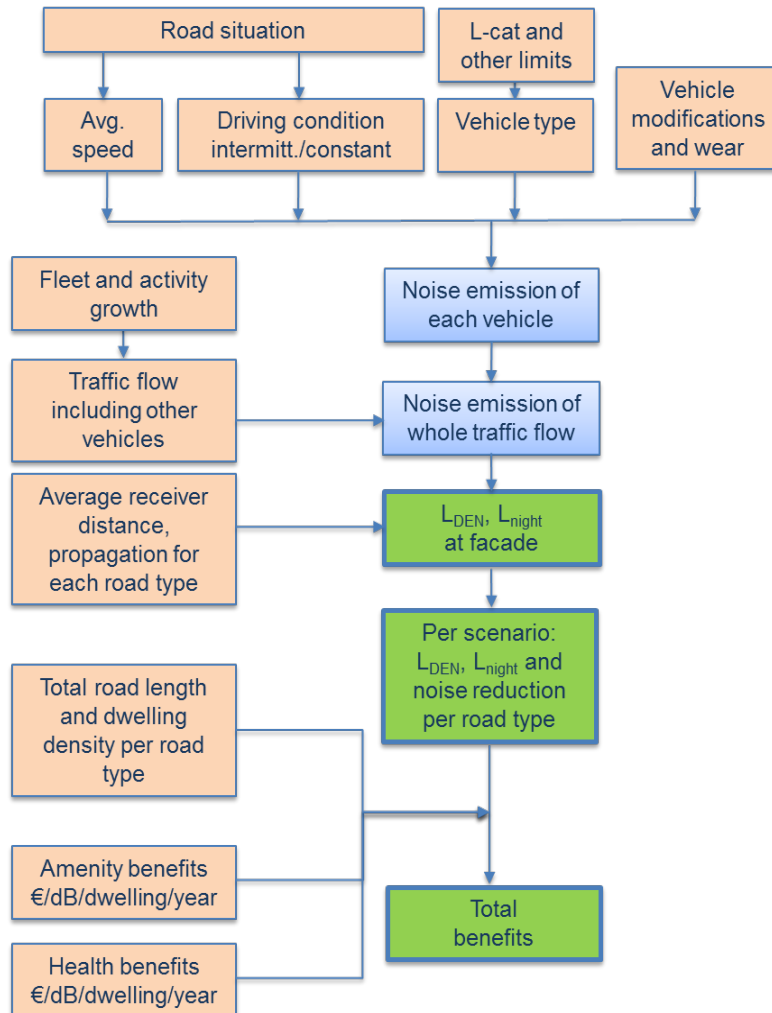
COST-BENEFIT ANALYSIS (CBA)

- › 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_{WOT} levels on roads under acceleration (also: cycle bypassing for the test method)
 - › new (lower) sound limits of **other vehicles** gradually taking effect

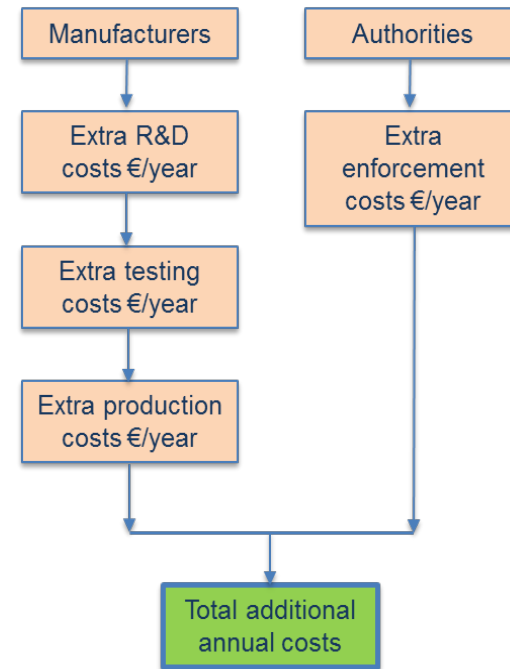


CBA METHODOLOGY

Benefits



Costs



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



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 =**

$$\frac{\text{Accumulated benefits over 20 year period}}{\text{Accumulated costs over 20 year period}}$$

› **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



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