L-vehicles Emissions and Noise mitigation Solutions

Addendum to Deliverable D3.4 Pollutants and noise emissions in the real world

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056777

Deliverable No.	D3.4	
Deliverable title	Pollutants and noise emissions in the real world	
Deliverable type	DATA	
Dissemination level	Public	
Deliverable leader	IDIADA	
Contractual due date	31.05.2025	
Actual submission date	23.07.2025	
Version	1.0	
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Reviewed by	Measurement partners	31.05.2025
Approved by	Measurement partners	31.05.2025

Revisions table

Version	Date	Change
1.0	23.07.2025	First submission to the EC

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Executive summary

This document is an addendum to deliverable D3.4. This deliverable focuses on the pollutant and noise emission data from real world measurements, i.e. conducted according to the recommended driving conditions defined in D6.1. Within the scope of this deliverable, a total 90 L-category vehicles for each type of measurement (pollutant and noise emissions) have been measured. The aim of this deliverable is to store the data in a well-defined structure and grant access to the public. This document is intended only as an aid to understanding the data structure and providing information on its accessibility.

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List of abbreviations

A/F	Air Fuel ratio
DB	Data Base
ECU	Engine Control Unit
EFM	Exhaust Flow Meter
GPS	Global Positioning System
ISO	International Organization for Standardization
LV	L-Category Vehicles
OBD	On Board Diagnostics
RD-ASEP	Real Driving-Additional Sound Emission Provisions
RDE	Real Driving Emissions
RW	Real World
SD	Secure Digital
TA	Type Approval
WP	Working Package

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1 Overview on vehicles tested

In this section, an overview is given on the vehicles that have been tested in the scope of this deliverable. The selected vehicles were chosen with the aim of covering all sub-categories of vehicles in the grand agreement. In addition, a representative selection of the current fleet was considered.

1.1 On-Road Pollutant Emissions

Table 1-1 provides an overview of the tested vehicles for the specific emission classes and LV subcategories. Overall, 112 vehicles have been measured on the public road. A total number of 12 corresponds to tampered vehicles.

Table 1-1: Overview of vehicles tailpipe emissions measured according to the recommended driving conditions defined in D6.1

LV sub category	Euro5	Euro4	< Euro 4	T-Cat	Tampered	Road measurements "On-Road exhaust emissions"	Road measurements "On-road and chassis dyno exhaust emissions"
L1e-B	6	6	11	0	2	19	4
L2e	0	0	1	0	0	1	0
L3e-A1	14	5	3	0	0	18	4
L3e-A2	14	9	2	0	4	20	5
L3e-A3	16	6	6	0	6	21	7
L3e-AxE	0	0	0	0	0	0	0
L4e-A1	0	0	0	0	0	0	0
L4e-A2	1	0	0	0	0	1	0
L4e-A3	0	0	0	0	0	0	0
L5e	4	0	1	0	0	4	1
L6e-A	0	0	0	0	0	0	0
L6e-B	2	0	0	0	0	0	2
L7e-B1	2	0	0	1	0	3	0
L7e-B2	0	0	0	2	0	1	1
Total	59	26	24	3	**12**	**88**	**24**

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1.2 Noise RW emissions

Figure 1-1 provides an overview of the tested vehicles for the specific emission classes and LV subcategories. Overall, 112 vehicles noise emissions have been measured following RW procedure defined by IKA on the public road and or on the proving ground. A total number of 2 corresponds to tampered vehicles.

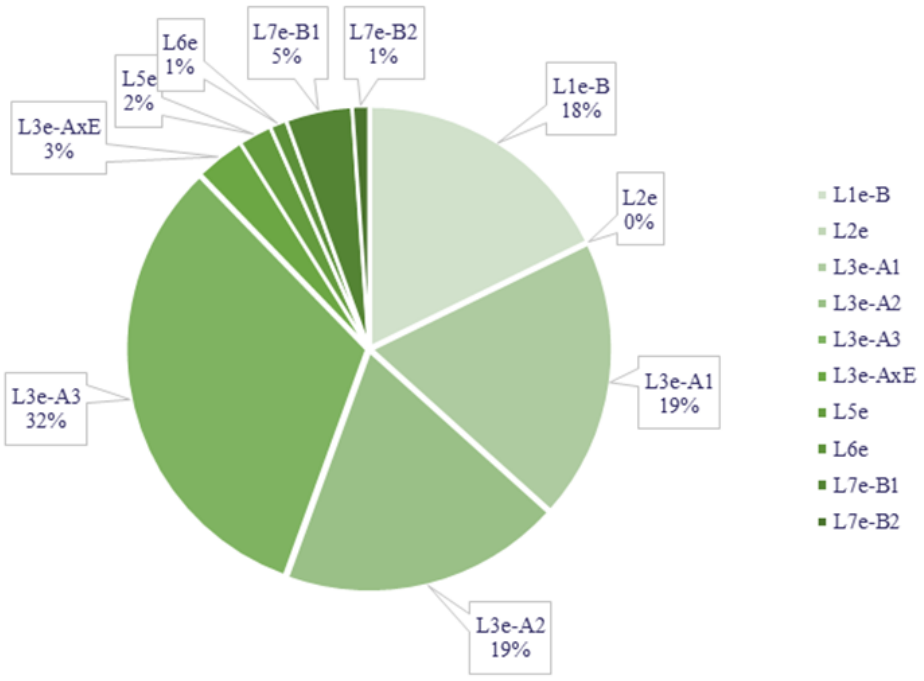

Figure 1-1: Overview of measured vehicles

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2 Observations

2.1 Vehicle matrix

In the progress of the vehicle procurement, as it was mentioned on D4.2, it was noticed that the availability of certain types of subcategories and emission classes is limited. This circumstance is due to the current fleet composition and market situation and led to the necessity to change the vehicle table which was stated in the Grant Agreement.

The following subcategories were affected:

- L6e-A Light on-road quad: this category is limited in power with 4kw and is not available on the market as new vehicle and not existing in the current fleet. No vehicle of this type could be procured.
- L7e-B1 All terrain quad: It was observed that the vast majority of this type is Type Approved in the vehicle category T (tractor) taking advantage of the considerably lower demands on emission reduction (less stringent requirements). For comparison reason several vehicles of the T category were measured.
- L7e-B2 Side by side buggies: Same scenario as on the L7e-B1 was observed regarding the B2 vehicles. These vehicles are restricted to a maximum of 15 kW net power and 450 kg of mass in running order (excluding driver) according to the regulation. Due to that performance restrictions and the lower demands on emissions reduction, the majority of these offroad vehicles are Type-Approved as category T. Although one real L7e-B2 Euro 3 was tested on chassis dyno exhaust emissions.

2.2 Exhaust Emissions Measurements constraints

Throughout the development of all emissions measurements on laboratory tests, several constraints have been identified, due to the different operating principle within vehicle categories, and limitation of data acquisition in old ones.

- ECU Communication with <EU3 vehicles: until Euro 4 standard, the OBD port was not mandatory according to the regulation. Some vehicles incorporate their own communication protocol, but it is not always accessible. In those kinds of vehicles, the data acquisition of engine monitoring signals is not available or should be measured by external sensors (i.e. temperature probes, string potentiometer, amperemeter clamp…)
- For data consistency an assessment of engine rpm is necessary for postprocessing of the data especially for tasks in WP6. This was done for nearly all vehicles.

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2.3 Exhaust Emissions Measurements uncertainty

Accuracy is pursued to the maximum extent possible. Although, some special scenarios could have affected the exact exhaust pollutant emissions measurements.

- Carburettor: the easy access (and therefore manipulation) and its sensitivity to the environment could result in undesirable A/F ratios, which in most cases are not monitored/adjusted by an ECU.
- Signals time correlation: analysers measure the concentration of some pollutants, so it is necessary to apply the exhaust flow to obtain the absolutes values of the pollutant's emission of the vehicle. In order to maximise the accuracy of the measurements, both EFM and analysers signal should be perfectly synchronized.
- In some cases, standard fuel from local gas stations was taken, no reference fuel.
- RDE Equipment represents an important contribution on the overall mass of the vehicle during on-road measurements. Moreover, aerodynamics is also affected by the equipment in terms of frontal area and the aerodynamic drag coefficient.
- RDE equipment used to develop all RDE measurements is not certified yet. Thee all were prototypes pending for validation with all the measurements developed. This could led into uncertainties during data acquisition.

2.4 Noise Emissions Measurements constraints

The conducted measurements are subject to strict constraints to ensure a high level of reproducibility and comparability of the results. The measurements must be carried out exclusively under specific meteorological conditions, for example, at wind speeds below 5 m/s and ambient temperatures between 5 °C and 45 °C. The background noise must be sufficiently low so that it does not distort the measurement results. Furthermore, the test track must be dry and comply with the very detailed requirements of ISO 10844 concerning surface properties, evenness and acoustic absorption. These conditions create a standardized but highly idealized test environment, which in some cases deviates significantly from real-world road conditions. In addition, the test procedures specify precise driving maneuvers. For example, during RD-ASEP tests, the engine speed at line BB' must not exceed 80% of the rated engine speed. Moreover, the execution of certain maneuvers, such as gear shift procedures followed by acceleration, is not always fully feasible on the 20-meter long test track, which limits the realizability of individual test conditions.

2.5 Noise Emissions Measurements uncertainty

To minimize measurement uncertainties, the regulations require a high degree of reproducibility. For example, during stationary noise measurements, three consecutive individual measurements must lie within a tolerance of 2 dB(A). Nevertheless, certain uncertainties exist, particularly in the capturing of psychoacoustic metrics (e.g., loudness or roughness), which can be attributed to natural variations or metrological limitations. A significant factor for variability is driver behaviour. This was especially evident in the driving pattern involving intermittent throttle control, which resulted in a significant spread of measurement values. This highlights the high variability of driver-dependent manoeuvres and their influence on the measurement results.

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3 Data structure and availability

3.1 Tailpipe emissions measurements data storage

Data storage of the results of all tailpipe emissions RDE measurements is included on LENS database (LENS DB), in the same way as all data from TA measurements, covered by D4.2. In the Addendum from D4.2, more detailed information about LENS DB architecture is described.

3.2 Noise emissions measurements data storage

The data collected within the project were recorded and analyzed in a structured form. During on-board measurements, sound pressure levels and GPS position data were recorded simultaneously via an on-board measurement system. The data were stored locally on micro-SD cards. For road-side measurements, the sound pressure level was captured over the entire measurement section. The collected data serve as the basis for deriving acoustic and psychoacoustic parameters (including sound pressure level, loudness, roughness), which are then evaluated specifically for each driving pattern and vehicle class. The results are visualized in the form of distributions, e.g. violin plots, to illustrate characteristic differences between vehicle classes and driving maneuvers.

Regarding the storage of seawater measurement data, these will be stored on the IKA server until the end of the project. Access will be possible via a temporary link. Once the LENS project is completed, all data will be transferred to EMISIA.

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