Addendum to Deliverable D4.2 Exhaust emission data from laboratory tests

Deliverable No.	D4.2	
Deliverable title	Exhaust emission data from laboratory tests	
Deliverable type	DATA	
Dissemination level	Public	
Deliverable leader	IDIADA	
Contractual due date	31.08.2024	
Actual submission date	28.02.2025	
Version	1.0	
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Revisions table

Version	Date	Change
1.0	28.02.2025	First submission to the EC

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Executive summary

This document is an addendum to deliverable D4.2. This deliverable focuses on the exhaust emission data from laboratory tests, i.e. conducted according to the current type-approval procedures for L-category vehicles. Within the scope of this deliverable, 60 L-category vehicles 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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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. Table 1.1 provides an overview of the tested vehicles for the specific emission classes and LV subcategories. Overall, 66 vehicles have been measured in laboratory tests, where 21 of them were tampered.

Table 1.1: Overview of tested vehicles according to current Type-Approval procedures

LV sub-category	Euro5	Euro4	< Euro 4	T-Cat	Tampered	Laboratory tests "Chassis dyno exhaust emissions"	Laboratory tests "On-road and chassis dyno exhaust emissions"
L1e-B	5	1	4	0	3	6	4
L2e	0	0	0	0	0	0	0
L3e-A1	5	2	4	0	0	8	3
L3e-A2	8	2	1	0	3	7	4
L3e-A3	14	3	2	0	11	12	7
L3e-AXE	4	0	2	0	4	6	0
L4e-A1	0	0	0	0	0	0	0
L4e-A2	0	0	0	0	0	30	0
L4e-A3	0	0	0	0	0	0	0
L5e	3	0	0	0	0	2	1
L6e-A	0	0	0	0	0	0	0
L6e-B	2	0	0	0	0	0	2
L7e-B1	0	0	0	1	0	1	0
L7e-B2	1	0	1	1	0	1	2
Total	42	8	14	2	21	43	23

2 Observations

Vehicle matrix

In the progress of the vehicle procurement, 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 (Grant Agreement Table 4 "First draft of test matrix in LENS").

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.

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.

• Old EU Standards vehicles: today's testing equipment is not suitable at all for those vehicles which are high emitters. Those vehicles can saturate the analysers that are being used nowadays. This might be especially valid for Euro 3 and older vehicles.

• 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.

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.

- Vehicles without canister: until the Euro 4 standard comes into force in 2016 with EC 168/2013, L-category vehicles were not required to incorporate canister to control the evaporative emissions. Due to that, some measurements could be slightly affected on account of ambient contamination.

- Analysers saturation: when measuring high emitters, "plateau effects" were identified in instantaneous data. The upper threshold of the analyser was reached so horizontal trends are shown on the instant data at certain engine operating scenarios.

- 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.

- FTIR measurement thresholds: CVS modules are very accurate when measuring exhaust pollutant emissions, however FTIR`s thresholds are not as lower as on the CVS. For those vehicles with low engine displacement, emissions are under that threshold so there is an important uncertainty in those sensitive emissions agents measured.

- Road loads: chassis dyno settings have been applied as outlined in 168/2014 based on the vehicle mass in running order also for offroad vehicles, which most probably deviate far from this table values due to low-pressure offroad tyres and non-aerodynamic vehicle design.

- In some cases, standard fuel from local gas stations was taken, no reference fuel.

3 Data structure and availability

To enable efficient analysis of the large amount of measurement data and to automatise the development of the parametrisation of the emission models developed in LENS, all emission test data is also imported into the LENS database (LENS_DB). TUG had designed a database for vehicle emission tests in the H2020 project "DownToTen" (grant agreement Nr. 724085). Afterwards this data base had been further developed and used for HBEFA1. All LENS partners involved in emissions' measurements agreed to adopt this database. TUG asked each of the LENS partners involved in emissions' measurements to contribute to the evolution/modification of the existing data template according to LENS measurements' requirements so as to develop a LENS data template for LENS_DB. TUG then synthesised the template of LENS_DB.

The database uses MySQL and is hosted on a server of TU Graz with strict access limitations to employees involved in the LENS project. All LENS partners can get access to the database via a frontend programmed in C#, based on the .Net framework 4.5. For this access partners need to register the users at TU Graz and get a unique password for accessing the database via the frontend (see Figure 3.1). The LENS_DB is daily backed up and the uploading and downloading of data can be seen schematically in Figure 3.2.
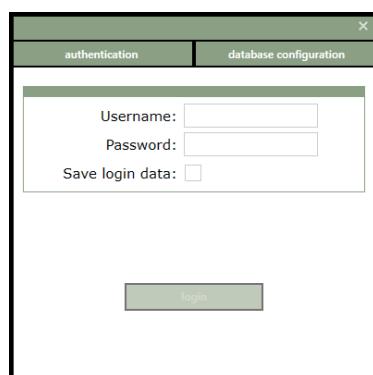
**Figure 3.1:** Log in window from the frontend app of the LENS_DB
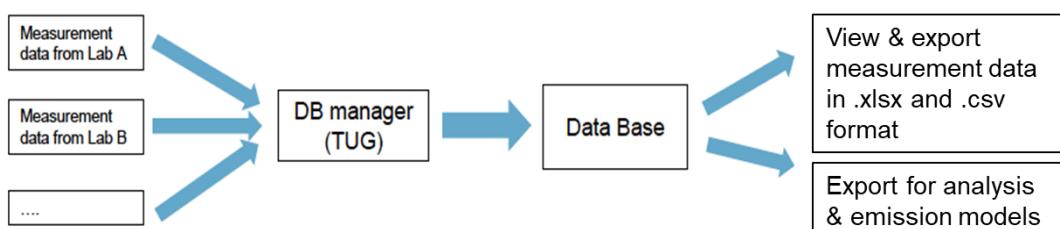
Figure 3.2: Schematic figure for LENS_DB uploading and downloading data

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[1] www.hbefa.net

The set-up and hosting of the LENS_DB is yet not covered by the LENS budget for TUG. As long as the expenses for this are not covered by reallocating uncalled project funds, TUG reserves the right to restrict access by partners. The data collected in the LENS database remains confidential and protected in all cases. To grant access to the public as indicated in the grant agreement, an on-demand access possibility is provided. Parties with justified interest must apply for access with their affiliation and will be provided with a unique password for the data front-end. Access to the public will be granted for processed data only, raw data access is restricted to the partners who collected data.

Typically, the following data are contained in the database:

- Metadata of the specific vehicles for vehicle type, brand, MY, milage and information about vehicle status and tampering.

- Test data from laboratory tests processed as summary data like test fuel consumption, test tail pipe emission for various components in g/km, and others.

- Test data from on-road tests processed as time resolved data for trip vehicle speed, route information, tail pipe emission for various emission components, as well as summary trip data.

- Further information on the data collected and open for public access can be found in D1.4 Final Data Management Plan.