European Commission

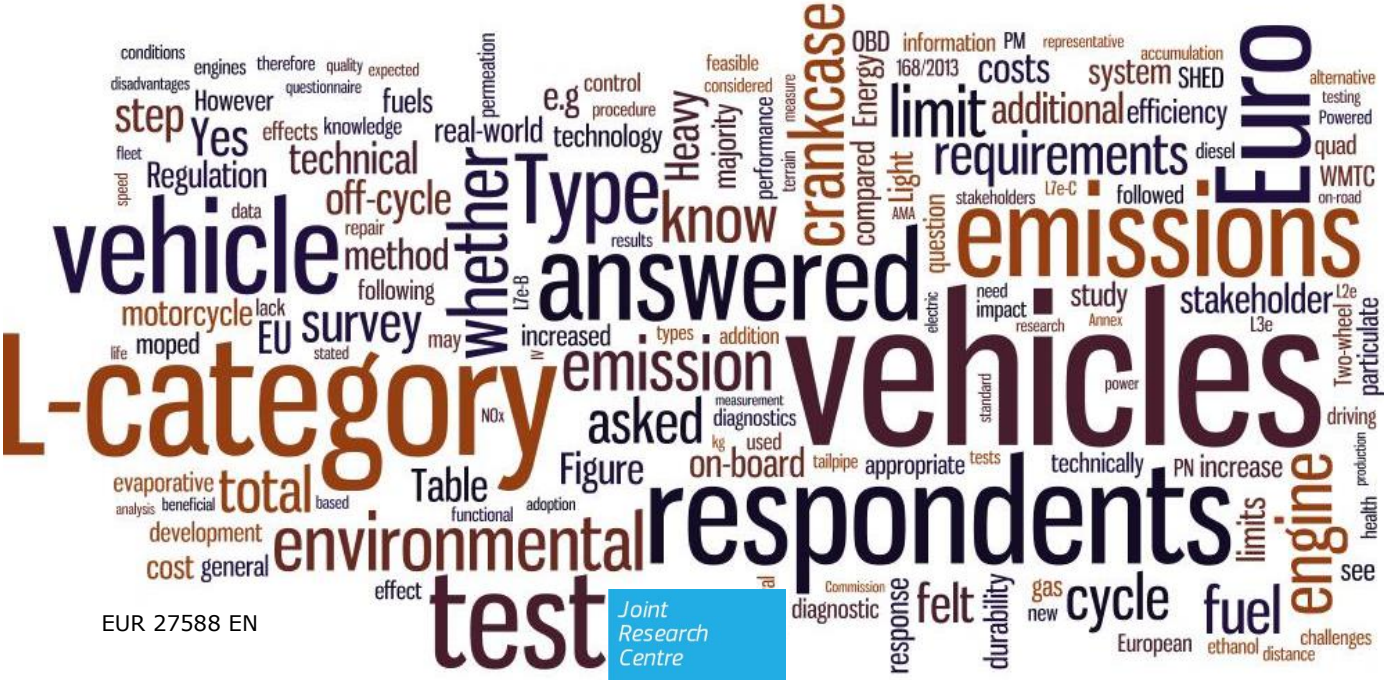
JRC SCIENCE FOR POLICY REPORT

Views on the Implementation of the Euro 5 Environmental Step for L-Category Vehicles

Results of a Questionnaire Survey

Gary Haq
Alessandro Zardini
Giorgio Martini

2016



EUR 27588 EN

Joint Research Centre

JRC Science Hub
https://ec.europa.eu/jrc

JRC98900

EUR 27588 EN

PDF ISBN 978-92-79-53929-9 ISSN 1831-9424 doi: 10.2790/974882 LD-NA-27588-EN-N

How to cite: Haq, G., Zardini, A. and Martini, G. (2016) Views on the Implementation of the Euro 5 Environmental Step for L-Category Vehicles; EUR 27588; doi 10.2790/974882

Abstract

European Union (EU) Regulation 168/2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles outlines harmonised rules for the type approval of L-category vehicles[1] in order to improve urban air quality. The Regulation also requires an environmental effects study to assess the implementation of the 'Euro 5 environmental step'.

On behalf of DG GROW, the EC Joint Research Centre (JRC) undertook an on-line questionnaire survey of public opinions on the application of the Euro 5 environmental step to L-category vehicles to inform the environmental effects study.

The survey was conducted in March – July 2015. A total of 101 (out of 1213) respondents participated in the online questionnaire survey. However, not all respondents completed all questions. The final analysis is therefore based on a total of 63 respondents, which is equal to a 5.2% response rate. The results provide a cross-section of views. This report presents the results of the questionnaire survey. It highlights a number of issues that should be considered in the environmental effects study in order to provide a better understanding of the impact of applying the Euro 5 step to L-category vehicles.

Table of contents

Abstract

European Union (EU) Regulation 168/2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles outlines harmonised rules for the type approval of L-category vehicles[1] in order to improve urban air quality. The Regulation also requires an environmental effects study to assess the implementation of the 'Euro 5 environmental step'.

On behalf of DG GROW, the EC Joint Research Centre (JRC) undertook an on-line questionnaire survey of public opinions on the application of the Euro 5 environmental step to L-category vehicles to inform the environmental effects study.

The survey was conducted in March – July 2015. A total of 101 (out of 1213) respondents participated in the online questionnaire survey. However, not all respondents completed all questions. The final analysis is therefore based on a total of 63 respondents, which is equal to a 5.2% response rate. The results provide a cross-section of views. This report presents the results of the questionnaire survey. It highlights a number of issues that should be considered in the environmental effects study in order to provide a better understanding of the impact of applying the Euro 5 step to L-category vehicles.

[1] L-category is the family name of light vehicles such as powered cycles, two- and three-wheeled mopeds, two-wheeled motorcycles with and without a side car, tricycles and quadricycles.

Executive summary

European Union (EU) Regulation 168/2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles (supplemented with EU Regulation 134/2014) outlines harmonised rules for the type approval of L-category vehicles in two steps. Euro 4 (new types: 2016) and Euro 5 (new types: 2020) steps for L-category vehicles assist in improving air quality by reducing the share of pollutant emissions emitted by L-category vehicles. L-category is the family name of light vehicles such as powered cycles, two- and three-wheeled mopeds, two-wheeled motorcycles with and without a side car, tricycles and quadricycles.

The 2009 impact assessment conducted prior to the adoption of EU Regulation 168/2013 concluded that mopeds and light motorcycles emit disproportionately high hydrocarbon (HCs) levels compared to other modes of road transport (e.g. cars, trucks and buses). However, the impact assessment considered only the application of the Euro 4 step to L-category vehicles. The 'Euro 5 environmental step' contains a package of measures designed to reduce particulate matter (PM) and ozone (O_3) precursors such as nitrogen oxides (NO_x) and HCs.

The Regulation requires an environmental effects study to provide additional information using modelling, technical feasibility and cost-effectiveness analysis based on the latest available data. On the basis of the study results, the European Commission (EC) should present a proposal to the European Parliament by 31 December 2016 introducing new elements into future type-approval legislation.

On behalf of DG GROW, the EC Joint Research Centre (JRC) was assigned the task to undertake a pre-study (experimental test programme) and Phase I (stocktaking and data mining, public survey, literature survey, detailed planning including costs) of the environmental effects study. As part of Phase I, an on-line questionnaire survey was conducted in March – July 2015 to gather public opinions on the application of the Euro 5 environmental step to L-category vehicles.

The results of the online questionnaire survey will contribute to the environmental effects study and assist in the formulation and drafting of proposals for the application of Euro 5 to L-category vehicles as well as providing scientific evidence to support proposals at the international level (via the United Nations Economic Commission for Europe, UNECE) for a standardised Euro 5 procedure.

An on-line questionnaire survey was considered the most cost-effective method to gather public opinions across the EU and internationally. The survey consisted of forty questions with a mixture of tick-box and open-ended answers (see Annex I).

Results

In total there was 101 (out of 1213) respondents to the online questionnaire survey. However, not all respondents completed all questions. The final analysis is therefore based on a total of 63 respondents which is equal to a 5.2% response rate. The results provide a cross-section of views on this issue.

The EU L-category vehicle is expected to increase over the next five years for L1e-powered cycles and L3 two-wheel motorcycles. Overall the implementation of the Euro 5 environmental performance requirements is seen as having environmental and health benefits in terms of reduced emissions levels. However, some believe that this measure will increase production (87.5%) and vehicle costs (44%). In particular, some

respondents question whether the World Motorcycle Test Cycle (WMTC) is representative of real-world engine conditions for L-category vehicles.

Type I – Tailpipe Emissions Tests After Cold Start
In general, respondents (48%) felt that it is technically feasible to comply with Euro 5 limits for HCs, NO_x and carbon monoxide (CO) using existing technologies. However, 54% of respondents answered 'Don't Know' when asked whether it was technically feasible for L-category vehicles to comply with particulate matter (PM) limits. There are additional technical challenges (e.g. use of post-treatment technology) and costs are estimated to be €101-200 for L1e (light-two wheeled vehicle) and L2e (three-wheeled moped) and €201-300 for L7e-B (heavy all terrain quads) and L7e-C (heavy quadri mobile). In addition, ethanol in fuel is expected to affect the Test IV evaporative emission test and lead to canister deterioration.

Type III – Emissions of Crankcase Gases
A total of 72% of respondents felt unburnt crankcase gas emissions are considered a threat to human health and environment but there is uncertainty whether crankcase emissions are higher than tailpipe emissions. 48% of respondents answered 'Don't Know' when asked whether inefficient operating crankcase system is expected to have a detrimental effect on engine life. With regard to whether the verification method for the crankcase ventilation system is appropriate and beneficial, a total of 74% of respondents answered 'Don't Know'.

Type IV - Evaporative Emissions
When asked whether the permeation test procedure or SHED was beneficial for selected L-category vehicles, a total of 72-73% of respondents answered 'Don't Know'. In addition, 58-62% answered 'Don't Know' when asked if a lower SHED test limit is appropriate for L-category vehicles or whether Euro 5 SHED test complaint vehicles need additional/modified hardware (57%).

Type V - Durability of Pollution Control Devices
When asked about the most appropriate type-approval durability test for L-category vehicles, the majority of respondents answered (49%) 'Don't Know'. Respondents also answered 'Don't Know' when asked about whether approved mileage accumulation (AMA) cycle should be phased-out (51%) and whether an increase in distance accumulation for L3e–A motorcycle is justified (58%)

Type VII - Energy Efficiency Test
A range of technologies has the potential to improve fuel efficiency of L-category vehicles (e.g. alternative fuels, battery technology, gas recirculation and intelligent transmission).

Functional On-Board Diagnostics and Type VIII - Environmental On-Board Diagnostic Test
On-board diagnostics (OBDs) is seen as providing better diagnostic quality information to the repairer as well as enhancing functional safety requirements and reducing repair costs to users. However, there may be increased vehicle costs for consumers, longer vehicle development, and production and increased research and development efforts.

Off-Cycle Emissions and Energy Efficiency Determination
It is generally considered that future off-cycle emission requirements should prevent the optimisation of the environmental performance of the vehicle to pass only the test type approval cycles and test procedures. An obligatory procedure should be followed to obtain reliable off-cycle emission and energy efficiency data for L-category vehicles. Chassis dynamometer tests can be used to obtain off-cycle information. However, the

impact of alternative fuels, technical feasibility of OBD stage II, standard battery package and an HC limit for off-cycle emissions require further investigation.

In conclusion, it can be seen from the survey results that there is uncertainty about specific aspects of adopting the Euro 5 step for L-category vehicles. In the opinion of the respondents, the environmental effects study should provide further analysis and clarifications on the following questions:[2]

- Does the WTMC represent real-world engine conditions for L-category vehicles?
- Can L-category vehicles adapted for technical progress meet the PM and PN limits?
- How significant are crankcase emissions?
- What effect do crankcase emissions have on the engine?
- What verification method can be used to assess crankcase emissions?
- Can the fuel permeation test be applied to certain types of L-category vehicles?
- What is the most appropriate durability test for L-category vehicles?
- What is the impact of alternative fuels, OBD stage II, standard battery package and an HC limit on off-cycle emissions on L-category vehicles?

[2] **Disclaimer:** only some of these stakeholders questions will be addressed in the environmental effects study, others are outside the scope or not relevant.

Table 1: L-category vehicles classification

L1e		**L2e**	**L3e**	**L4e**	**L5**		**L6e**		**L7e**		
Light two-wheeled vehicle		***Three-wheel moped***	***Motorcycle***	***Motorcycle with side car***	***Tricycles***		***Light quadricycle***		***Heavy qudricycle***		
L1e-A *Powered cycles*	**L1e-B** *Moped*	**L2e**	**L3e**	**L4e**	**L5e-A** *Tricycles*	**L5e-B** *Commercial tricycles*	**L6e-A** *Light quad*	**L6e-A** *Light mini car*	**L7e-A** *On-road quad*	**L7e-B** *Heavy all terrain quad*	**L7e-C** *Heavy Quad mobile*
		L2e-P	L3e-A1	L4e-A1				L6Be-P	 L7e-A1	L7e-B1 L7e-B1	L7e-CU L7e-CU
		L2e-U	L3e-A2	L4e-A2				L6Be-U	 L7e-A2	L7e-B2 L7e-B2	 L7e-CP
			L3e-A3	L4e-A3							
≤50cc, ≤25 km/h, <4 kW, C-O 25kmh, 250 W continuous rated or net power ≤1000 W	≤50cc, ≤45 km/h, <4 kW	≤50cc, ≤45 km/h, <4 kW, ≤270 kg	<= 11 kW, A2: <=35 kW		3W, <1000 kg,	3W, <1000 kg, max 2 seats, V 0.6m^3	<4kW, ≤425 kg, ≤45 km/h (D, G)	<6kW, <425 kg, ≤45 km/h (D, G)	<15kW, ≤450 kg	W/G<6, ≤450 kg	P: ≤450 kg, U: ≤600 kg, (D, G)

). Euro 4 (new types: 2016) and Euro 5 (new types: 2020) steps for L-category vehicles assist in improving (urban) air quality by reducing the share of pollutant emissions emitted by L-category vehicles.

The 2009 impact assessment conducted prior to the adoption of EU Regulation 168/2013 concluded that mopeds and light motorcycles emit disproportionately high hydrocarbon (HCs) levels compared to other modes of road transport (e.g. cars, trucks and buses). However, the impact assessment considered only the application of the Euro 4 step to L-category vehicles. The 'Euro 5 environmental step' contains a package of measures designed to reduce particulate matter (PM) and ozone (O_3) precursors such as nitrogen oxides (NO_x) and HCs.

The Regulation requires an environmental effects study to provide additional information using modelling, technical feasibility and cost- effectiveness analysis based on the latest available data. In addition, the study should, *inter alia*, assess the feasibility and cost-effectiveness of in-service conformity testing requirements, off-cycle emission requirements and a particulate number (PN) emission limit for certain (sub-) categories.

On the basis of the study results, the European Commission (EC) should present a proposal to the European Parliament by 31 December 2016 introducing new elements into future type-approval legislation.

On behalf of DG GROW, the EC Joint Research Centre (JRC) was assigned the task to undertake a pre-study (experimental test programme) and Phase I (stocktaking and data mining, public survey, literature survey, detailed planning (including costs)) to provide the basis for Phases II and III of the environmental effects study. As part of this task, an on-line questionnaire survey was conducted in March – July 2015 to gather public opinions on the adoption of the Euro 5 limit for L-category vehicles. This report outlines the findings of the on-line questionnaire survey.

Table 1: L-category vehicles classification

L1e		**L2e**	**L3e**	**L4e**	**L5**		**L6e**		**L7e**		
Light two-wheeled vehicle		***Three-wheel moped***	***Motorcycle***	***Motorcycle with side car***	***Tricycles***		***Light quadricycle***		***Heavy qudricycle***		
L1e-A *Powered cycles*	**L1e-B** *Moped*	**L2e**	**L3e**	**L4e**	**L5e-A** *Tricycles*	**L5e-B** *Commercial tricycles*	**L6e-A** *Light quad*	**L6e-A** *Light mini car*	**L7e-A** *On-road quad*	**L7e-B** *Heavy all terrain quad*	**L7e-C** *Heavy Quad mobile*
		 L2e-P	 L3e-A1	 L4e-A1				 L6Be-P	 L7e-A1	 L7e-B1	 L7e-CU
		 L2e-U	 L3e-A2	L4e-A2				 L6Be-U	 L7e-A2	 L7e-B2	 L7e-CP
			 L3e-A3	L4e-A3							
≤50cc, ≤25 km/h, <4 kW, C-O 25kmh, 250 W continuous rated or net power ≤1000 W	≤50cc, ≤45 km/h, <4 kW	≤50cc, ≤45 km/h, <4 kW, ≤270 kg	<= 11 kW, A2: <=35 kW		3W, <1000 kg,	3W, <1000 kg, max 2 seats, V 0.6m^3	<4kW, ≤425 kg, ≤45 km/h (D, G)	<6kW, <425 kg, ≤45 km/h (D, G)	<15kW, ≤450 kg	W/G<6, ≤450 kg	P: ≤450 kg, U: ≤600 kg, (D, G)

2. Questionnaire Survey

The introduction of the Euro 5 environmental performance requirements for L-category vehicles may affect a wide range of stakeholders. These include manufactures, suppliers and aftermarket suppliers, approval authorities and testing agencies and consumers.

As part of an initial phase of the environmental effects study on the Euro 5 step of L-category vehicles, the JRC undertook an on-line questionnaire survey during the period 30 March to 10 July 2015.

The objective of the public survey was two-fold:

- to gather opinions of stakeholders on the adoption of the Euro 5 limit for L-category vehicles; and
- to acquire input for the environmental effects study (e.g. cost).

The results of the survey will contribute to the environmental effects study and assist in the formulation and drafting of proposals for the application of Euro 5 to L-category vehicles as well as providing scientific evidence to underpin proposals at the international level (i.e. the United Nations Economic Commission for Europe (UNECE)).

2.1 Methodology

An on-line questionnaire survey was considered the most cost-effective method to gather public opinions across the EU and internationally. The survey consisted of forty questions with a mixture of tick-box and open-ended answers (see Annex I).

A database of stakeholder contacts was compiled from participants who attended European and international technical groups related to transport issues (e.g. UNECE Environmental and Propulsion Performance Requirements of L-category vehicles (EPPR) informal working group).

A website link was circulated to members of technical groups promoting the survey. In addition, a total of 1,126 key international and European stakeholders were sent an email inviting them to participate in the on-line consultation on the 30 March 2015. Three further email reminders were sent out on the 17 April (982), 11 May (964) and 26 June (952). Of this number a total of 5.2% responded (58), 1% opted out (11), 10.1% bounced (114), and 83.8% did not respond at all (944). A further email containing the website link was sent to an additional 87 contacts (not in the original list) on 16 June 2015. A total of 34 responses were gained via the website link.

In total there was 101 (1213) respondents to the questionnaire survey. This is equal to an 8% response rate. However, not all respondents completed all the questions or included essential information such as name and type of organisation. Since it was not possible to confirm any association with a stakeholder group these responses had to be removed from the analysis together with double entries.

The final analysis is therefore based on a total of 63 respondents which is equal to a 5.2% response rate.

3. Results

3.1 Type of Stakeholder

A total of 35% (22) of the respondents were from industry (e.g. manufacturer) or industry representative, 19% (12) were type approval authorities, 17.5% (11) were classified as 'other' (e.g. technical service, NGO, national research centre, trade association, private consultancy, test equipment manufacturer), 11% (7) policy maker on environmental requirements, 8% (5) technical services provider and another 8% (5) for other governmental organisations not mentioned and 1.5% (1) as a rider or user association (see Figure 1).

3.2 Type of Vehicles

The commonest vehicles the respondents deal with are L3e two-wheel motorcycles (77%), L6e-B light quadri-mobile (56%), L5e-A tricycles (55.5%), L7e-C heavy quadri-mobile (53.23%) followed by L7e-B heavy all terrain quad and L7e heavy on-road quad (52%) (see Figure 2).

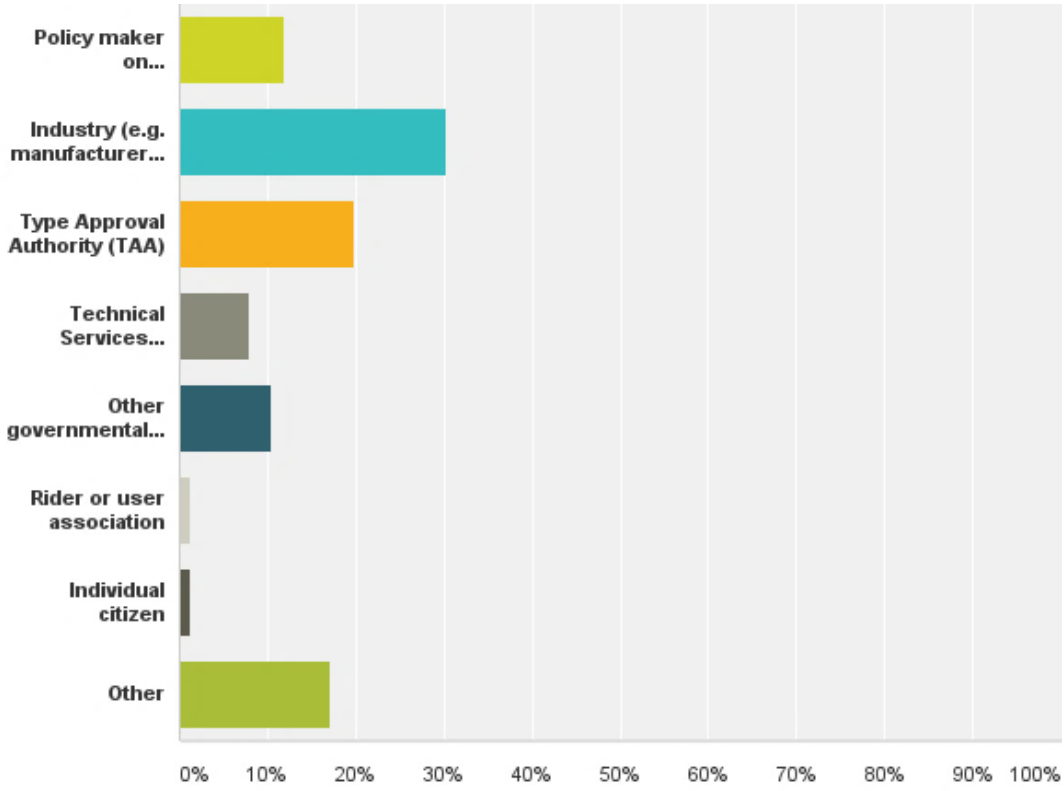


Figure 1: Type of stakeholder

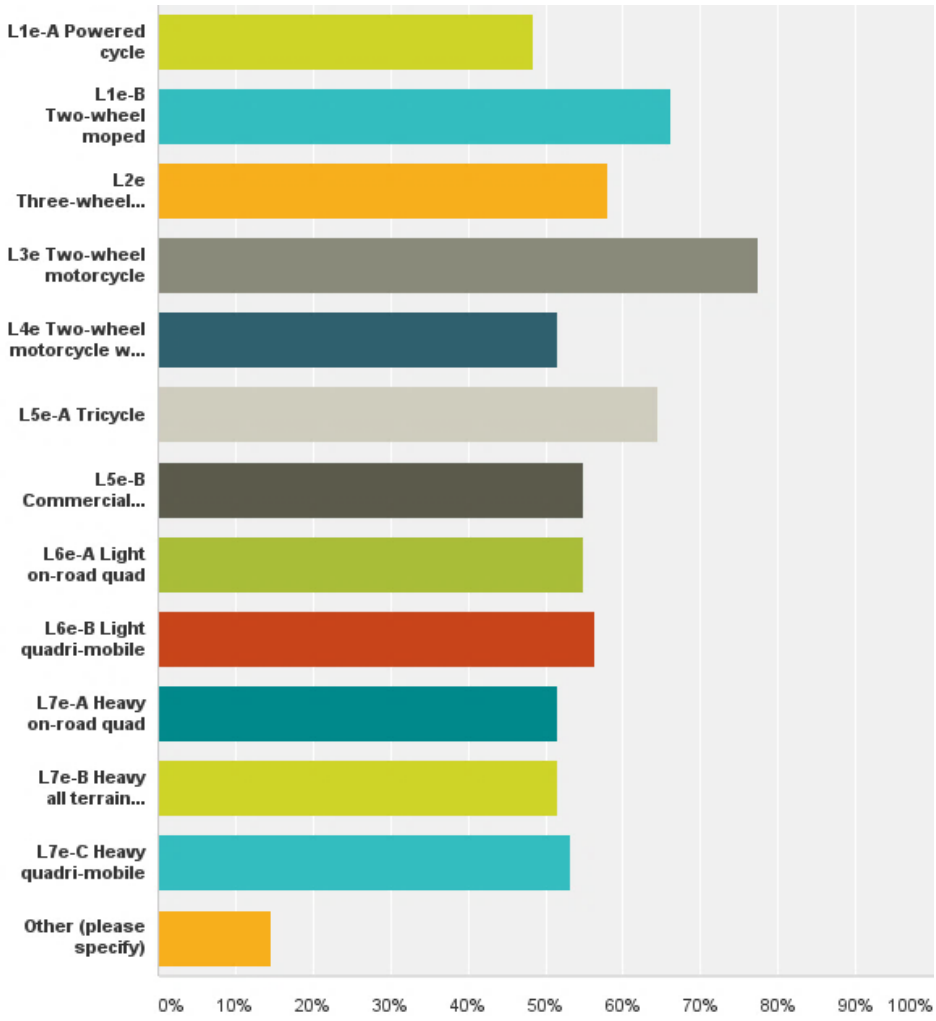


Figure 2: Types of vehicles the respondents deal with

3.3 Development of the EU L-Category Vehicle Fleet

Respondents were asked how they saw the EU L-category vehicle fleet developing over the next five years (see Table 2). A total of 65% (30/46) saw the L1e-powered cycle and 50% (23/46) saw L3 Two-wheel motorcycle increasing. In contrast, 39% (17/44) of respondents saw L6e-B light quadri-mobiles staying the same while two stated 'other':

- L6 B: specific customers without B driving licence and unable to ride a powered two-wheeler (PTW) L7 C: increase of the market is only anticipated for electric propulsion models.

- More persons will use the lighter vehicles which might result in less fuel consumption and congestion.

Table 2: Expected development of the EU L-category vehicle fleet

How do you see the development of the L-category vehicle fleet as a share of the total EU transport fleet over the next 5 years? For example, in 2012 L-category vehicles represented 8-23% of total vehicle fleet in the EU: Germany (8%), Greece (23%) Italy (13%), Spain (9%) (Eurostat, 2015).						
Answer Options	**Increase**	**Stay the same**	**Decrease**	**Don't Know**	**Rating Average**	**Response Count**
L1e-A Powered cycle	30	0	0	16	2.04	46
L1e-B Two-wheel moped	17	8	9	12	2.35	46
L2e Three-wheel moped	7	13	5	22	2.89	47
L3e Two-wheel motorcycle	23	13	0	10	1.93	46
L4e Two-wheel motorcycle with side-car	2	11	10	21	3.14	44
L5e-A Tricycle	13	13	3	15	2.45	44
L5e-B Commercial tricycle	4	14	5	22	3.00	45
L6e-A Light on-road quad	6	10	4	23	3.02	43
L6e-B Light quadri-mobile	11	17	1	15	2.45	44
L7e-A Heavy on-road quad	4	12	4	24	3.09	44
L7e-B Heavy all terrain quad	7	10	4	23	2.98	44
L7e-C Heavy quadri-mobile	11	10	3	19	2.70	43
					answered question	**50**
					skipped question	**13**

3.4 Advantages and Disadvantages of Implementing the Euro 5 Environmental Step for L-Category Vehicles

With regard to the perceived benefits of implementing the Euro 5 environmental step, respondents felt it would reduce pollution (96%), protect public health (63%), increase energy efficiency (50%) and decrease greenhouse gas (GHG) emissions (44%) (see Figure 3). In contrast, 87.5% (42/48) of respondents saw increased production costs, 48% (19/48) technical challenges and 44% (21/48) significant vehicle price increases (due to on-board diagnostic capability (stage 2)) as the key disadvantages of implementing this measure (see Figure 4).

3.5 WMTC Represenative of Real-World Driving Emissions

Respondents were asked whether the worldwide harmonized motorcycle test cycle (WMTC) is representative of real-world driving emissions for L-category vehicles. Table 3 shows that the response to this question is mixed between 'Yes', 'No' and 'Don't Know' and no significant conclusion can be drawn.

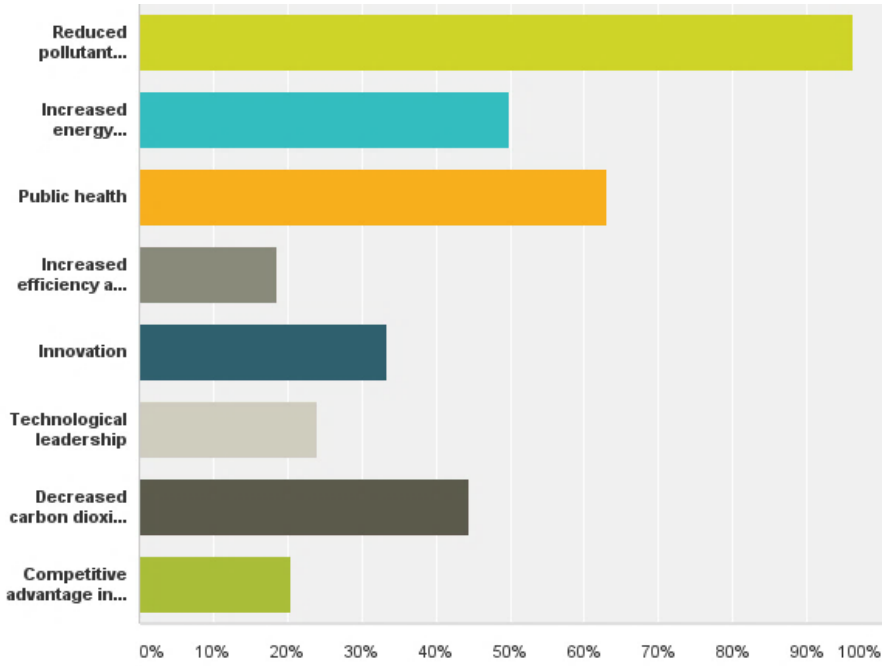


Figure 3: Benefits of implementing the Euro 5 Limit

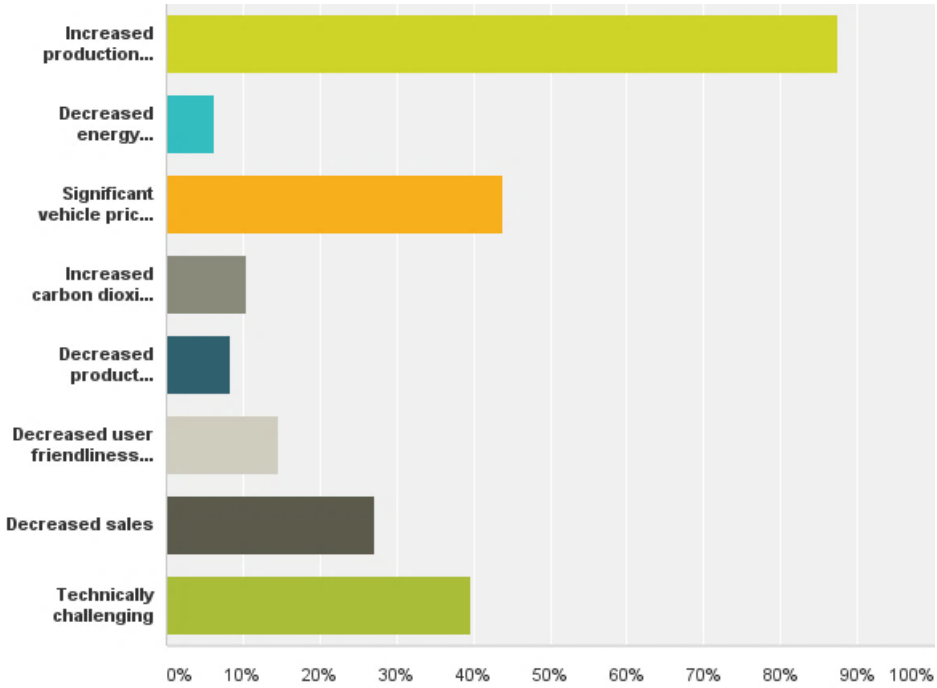


Figure 4: Disadvantages of implementing the Euro 5 Limit

Table 3: WMTC and Real-World Driving Emissions

Do you think the WMTC is representative of real-world engine operating conditions for L-category vehicles?					
Answer Options	**Yes**	**No**	**Don't Know**	**Rating Average**	**Response Count**
L1e-A Powered cycle	11	10	23	2.27	44
L1e-B Two-wheel moped	15	10	18	2.07	43
L2e Three-wheel moped	12	11	19	2.17	42
L3e Two-wheel motorcycle	19	11	14	1.89	44
L4e Two-wheel motorcycle with side-car	16	9	17	2.02	42
L5e-A Tricycle	15	9	19	2.09	43
L5e-B Commercial tricycle	11	9	23	2.28	43
L6e-A Light on-road quad	12	7	24	2.28	43
L7e-A Heavy on-road quad	11	9	23	2.28	43
L7e-B Heavy all terrain quad	8	9	27	2.43	44
L7e-C Heavy quadri-mobile	9	10	25	2.36	44
				answered question	**48**
				skipped question	**15**

3.6 Type I – Tailpipe Emissions Tests After Cold Start

Regulation EU 168/2013 proposes Euro 5 emission limits for new types of L-category vehicles from 1 January 2020 (see Table 4).

Table 4: Euro 5 Emission Limits

Vehicle category	Vehicle category name	Propulsion data	Euro level	Mass of CO	Mass of THC	Mass of NHMC	Mass of NO_X	Mass of PM	Test Cycle
				L1 (mg/km)	L2A (mg/km)	L2B (mg/km)	L3 (mg/km)	L4 (mg/km)	
L1e-A	Powered cycle	PI/CI/Hybrid	Euro 5	500	1000	68	60	4.5	Revised WMTC
L1e-B-L7e	All other L-category vehicles	PI/PI Hybrid	Euro 5	1000	100	68	60	4.5	Revised WMTC
		CI/CI Hybrid		500	100	68	90	4.5	Revised WMTC

3.6.1 Total hydrocarbon and nitrogen oxides

A total of 48% of respondents believe it was technically feasible to comply with the proposed Euro 5 limit for HCs and NO_x compared to 38% who didn't know and 14% who felt it was not technically feasible.

Where the respondents answered 'Yes', the reasons given include better use of existing technologies to achieve the emission limits (e.g. electronic fuel injection, exhaust gas recirculation, lambda (air fuel ratio) sensors, three-way catalysts and electronic control units, conversion to compressed natural gas (CNG) or bio-methane).

One respondent highlighted technical and 'packaging' challenges (i.e. compact design of all-terrain and side by side vehicles) and that chassis and bodywork restricts the available space for additional after treatment equipment for certain vehicles resulting in high cost.

One respondent suggested that in the mid-term electrification of two-wheelers is the only way forward. Powered 2-, 3- and 4-wheelers should have in her/his view zero tailpipe emissions to comply with air pollution limits and GHG reduction targets. China was given as an example of a country which has demonstrated that electric L-category vehicles can compete economically with internal combustion engines and be cost-effective.

For those respondents who felt the Euro 5 limit was technically unfeasible for L-category vehicles, the following reasons were given:

- insufficient exhaust temperature for three-wheel motorcycles
- HC and NO_x limits too low for mopeds with the additional cost of meeting the limit affecting sales
- WMTC load for motorcycles (>=125cc) means NO_x levels will be difficult to reach
- New vehicle catalysts do not meet manufacturers' claims
- Opacity rather than particles should be measured in order to get a more accurate assessment of soot and tar in the vehicle exhaust.

3.6.2 Non-methane hydrocarbons

Respondents were asked whether other methods would be valid to assess non-methane hydrocarbons (NMHC) instead of direct measurement.

The majority of the respondents (71%) felt that direct measurement was the only reliable method to measure NMHC while 14% felt estimates based on engine parameters would be valid. In contrast, a total of 16% stated they didn't know and/or made the following points:

- direct measurement is the only reliable method for emission testing
- estimates on vehicle parameters could be a solution for small manufacturers using the propulsion system of an already type-approved vehicle
- an appropriate NMHC limit needs to be determined rather than an alternative measurement method.

3.6.3 Carbon monoxide

A total of 63% of respondents felt it was technically feasible to meet the proposed CO Euro 5 limit for L-category vehicles compared to 2% who answered 'No' and 35% who answered 'Don't Know.'

Those who answered 'Yes', felt existing technology (e.g. catalysts) could be used by the auto-industry to meet the limit. Others questioned the justification for a low limit and highlighted both the technical and design challenges and that it may not be cost-beneficial given the limited number of units sold.

3.6.4 Particulate matter

When asked whether it was technically feasible for L-category vehicles to comply with the Euro 5 limit for PM, 46% of respondents answered 'Don't Know' while 44% answered 'Yes' compared to 10% who answered 'No'.

Respondents who answered 'Yes' felt that emission limits could be achieved by using current technology (e.g. 4-stroke oxidation catalysts, PM sensors in exhaust pipe and diesel particulate filters), improving fuel quality and switching to alternative fuels such as liquid petroleum gas (LPG), compressed natural gas (CNG) or electrification.

Others who answered 'No' or 'Don't Know' highlighted the uncertainty surrounding the following issues:

- lack of data available for petrol direct injection
- excessive cost incurred, especially for diesel quadricycles
- Need to deal with diesel particulate filter (DPF) regeneration control for vehicle with limited speed
- lack of measurement devices.

Respondents were also asked whether it was technically feasible for L-category vehicles to comply with a Euro 5 limit for PN.

A total of 54% of respondents answered 'Don't know', while 33% answered 'Yes' and 12.5% answered 'No'.

Those respondents who answered 'Yes' highlighted the need to address ultrafine PM due to the impact on human health. There was a general feeling that there should be no discrimination between conventional motor vehicles and L-category vehicles as the impact on health is the same. PN is especially important for gasoline direct injection engines, and should be further controlled.

Those who answered 'No' felt that there was no scientific evidence that PN has any impact on human health and that it was costly to implement with no real added-value. In addition, a PN limit is related to gasoline particulate filter (GPF) technology. The GPF-technology will probably not be applied in practice.

One respondent argued the majority of PM_{10} comes from the wear of asphalt and rubber tyres rather than vehicle exhaust emissions and as a consequence electric vehicles will have the same problem. It was felt that too much focus was placed on vehicles with combustion engines.

Respondents were also asked whether it would be beneficial to have a PN limit in addition to a PM limit. A total of 42% answered 'Yes' while 36% did not know and 22% were against the idea.

When asked whether it was meaningful to apply the same method used to measure PN in passenger to L-category vehicles, the response was mixed (see Table 5). The majority of respondents answered 'Don't Know' with the exception of L3e, L4e and L5e-A, where respondents were more positive of applying methods used in passenger vehicles to these L-category vehicles.

3.6.5 Technical challenges

Respondents were asked whether they saw any additional technical challenges in complying with the proposed Euro 5 limits compared to the Euro 5 diesel L-category. A total of 53% felt there were additional challenges compared to 43% who didn't know and 4% who felt there were no additional challenges.

The reasons given for those who felt there were additional technical challenges included:

- Technically complexity which result increased cost
- Insufficient vehicle power will result in insufficient exhaust temperature and therefore will make the implementation of post-treatment technology technically difficult.
- NO_x limits are more difficult to comply with compared to gasoline L-category vehicles
- On-road real-world measurements need to be undertaken to avoid HC and other pollutant emission gaps between laboratory and on road tests.
- The Euro 5 proposed limits need to make sure the emission control devices operate under all normal condition of use.
- From the engine manufacturer standpoint, this will result in an increase in engine cost; mass, dimensions, complexity; and a need for large engine development efforts, production equipment upgrade and service network update.
- The Euro 5 requirements will be forced to adopt the current M/N engine and vehicles technology on L-category vehicles. In particular, the following engine systems are deemed necessary: Advanced combustion system; DI type - Advanced fuel injection system, common-rail type; EGR system, with cooler and electronically controlled valve; Turbocharger with pneumatic wastegate; PM after-treatment system, with diesel oxidation catalyst (DOC) and particulate filter (DPF); NO_x after-treatment system, likely SCR type; ECU (Engine Control Unit) with OBD, DPF regeneration and SCR control capabilities.

Table 5: PN Measurement Method

Do you think it would be meaningful to apply the same method used to measure Particle Number in Passenger Cars to L-category vehicles?					
Answer Options	**Yes**	**No**	**Don't Know**	**Rating Average**	**Response Count**
L1e-A Powered cycle	15	10	18	2.07	43
L1e-B Two-wheel moped	15	8	19	2.10	42
L2e Three-wheel moped	14	8	18	2.10	40
L3e Two-wheel motorcycle	20	7	15	1.88	42
L4e Two-wheel motorcycle with side-car	18	7	16	1.95	41
L5e-A Tricycle	20	7	15	1.88	42
L5e-B Commercial tricycle	20	7	15	1.88	42
L6e-A Light on-road quad	19	7	15	1.90	41
L7e-A Heavy on-road quad	19	6	16	1.93	41
L7e-B Heavy all terrain quad	18	7	17	1.98	42
L7e-C Heavy quadri-mobile	19	6	16	1.93	41
Other (please specify)					9
			skipped question		**18**

3.6.6 Additional costs

With the regard to costs that may result from the modification to Type I test cycle (e.g. emission limits, WMTC and adoption of new test cycle), the majority of respondents felt there would be an additional of cost of €101-200 for L1e (light two-wheeled vehicle (powered cycle or two-wheeled moped)) and L2e (three-wheeled moped) vehicle categories (see
Table **6**). The estimated cost for L5e-B (commercial tricycle), L7e-B (heavy all terrain quads) and L7e-C (heavy quadri mobile) were estimated to be €201-300.

3.6.7 Effects of ethanol in fuel

In some EU Member States the reference test fuel contains a specified amount of ethanol (5%), respondents were asked whether the effect of ethanol in fuel was important (see Figure 5). A total of 68% of respondents felt that ethanol in fuel would have an effect on the Test IV evaporative test and would lead to canister deterioration due to ageing (57%), increased tank permeation (54%) and effect Test V durability test.

Table 6: Possible Additional Costs of Modifying the Type I test cycle

Please indicate the possible additional costs per vehicle that may result from the modification to Type I test cycle (e.g. emission limits, WMTC, adoption of new test cycle).

Answer Options	**< 50 €**	**51 - 100 €**	**101 - 200 €**	**201 - 300 €**	**301 - 400 €**	**401 - 500 €**	**500 - 700 €**	**700 - 900 €**	**900-1000 €**	**>1000 €**	**Response Count**
L1e: Light two-wheeled vehicle (powered cycle or two-wheeled moped)	33 %	8%	46%	8%	0%	0%	0%	0%	0%	4%	24
L2e: Three-wheeled moped	27 %	18%	36%	14%	0%	0%	0%	0%	0%	5%	22
L5e-B: Commercial triycle	26 %	4%	22%	35%	4%	0%	4%	0%	0%	4%	23
L6e-B: Light Quadrimobile	22 %	0%	26%	30%	4%	4%	4%	0%	0%	9%	23
L7e-B: Heavy all terrain quads	17 %	8%	17%	29%	13%	8%	4%	0%	0%	4%	24
L7e-C: Heavy quadri mobile	17 %	8%	17%	29%	13%	8%	4%	0%	0%	4%	24
								answered question			**28**
								skipped question			**35**

3.7 Type III: emission of crankcase gases

Crankcase emissions consist of HCs from unburned fuel and lubrication oil coming from the engine. Unburned vapours are usually returned to the intake system of the engine where they are combusted. However, these emissions can be released into the ambient atmosphere if the crankcase ventilation system is not adequately designed or sealed. Annex V of Regulation 168/2013 sets out the requirement to limit such emissions:

"*Zero emission, closed crankcase. Crankcase emissions shall not be discharged directly into the ambient atmosphere from any vehicle throughout its useful life*."

A total of 72% of respondents felt that unburnt emissions from the crankcase of L-category vehicles pose a threat to human health and environment if they are released to the ambient atmosphere compared to 22% who did not know and 6.5% who thought such emissions did not pose a health threat.

Those who answered 'Yes' felt crankcase gas emissions are a similar health threat as evaporative fuel and tailpipe exhaust emissions although in smaller amounts. This is especially the case for petrol and diesel fuelled vehicles.

Those who answered 'No' or 'Don't Know' were unaware that crankcase emissions escape into the ambient atmosphere as the crankcase is assumed to be sealed in L-category vehicles.

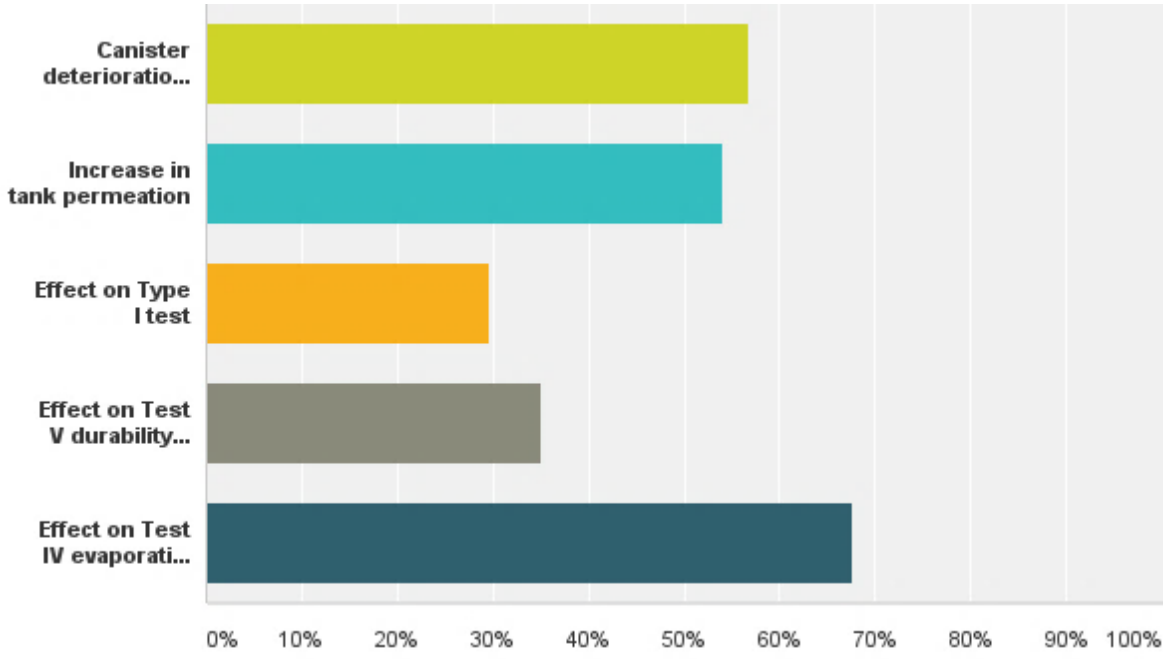


Figure 5: Effects of Ethanol Fuel

Respondents were asked whether inefficient operating crankcase systems (based on over pressure and not on vacuum) are expected to have a detrimental effect on engine life (combination of lubrication oil with unburned fuel, water vapour, and particles). A total of 48% of respondents did not know while 33% answered 'Yes' and 20% answered 'No'.

Those respondents who answered 'Yes' stated that accumulated crankcase emissions can develop into the engine, damaging materials. Unburned fuel from normal petrol and diesel oil together with soot and tar can destroy lubrication and engine oils. If there is under-pressure in the crankcase systems, ultra-fine road particles may be sucked into the crankcase and may lead to destruction of lubrication oils, However, it was felt the majority of these particles up to 10µm are due to wear of asphalt, tyres and are not from fuel combustion.

Respondents were asked whether they thought crankcase emissions of L-category vehicles are substantial compared to tailpipe emissions. A total of 45.5% answered 'Don't Know' followed by 34% who answered 'No' compared to 20.5% who answered 'Yes'.

Those respondents who answered 'No' stated that the crankcase is completely sealed and there are no emissions to the ambient atmosphere. In contrast, those who answered 'Yes' gave the following reasons for the substantial crankcase emissions:

- low life expectancy and poor maintenance of the engine
- high rev engines and low cost manufacturing processes creating more crankcase emissions
- presence in engines with cleaner exhaust gases.

With regard to the verification method for the crankcase ventilation system (out of the two additional type III test methods proposed in Annex IV of Regulation 134/2014), respondents were asked which they considered the most technically demanding.

A total of 74% of the respondents answered 'Don't Know' followed by 15% who felt the over pressure method was more demanding compared to 11% who felt vacuum-based method more technically demanding. Some respondents felt that the over pressure method was more accurate while the vacuum-based method could harm the engine and was more difficult to achieve every time.

Finally, respondents were asked which verification method for the crankcase ventilation system was the most beneficial. Only 19 respondents answered this open-ended question. The majority stated 'Don't Know', while other re-stated that there were no crankcase emissions.

3.8 Type IV: Evaporative Emissions

With regard to evaporative emissions, the vehicle manufacturer needs to prove to the technical service, and to the satisfaction of the approval authority, that the fuel tank and fuelling system are leak-tight.

All L-vehicle (sub-) categories equipped with a non-metallic fuel storage should be tested according to the permeability test procedure laid down in Appendix 1, Annex V of Regulation 134/2014.

The fuel permeation test (Appendix 2) or the SHED test (Appendix 3) may replace the evaporative part of the permeability test (Appendix 1) of the Euro 5 step for vehicle types which are not yet in the scope of evaporative emission testing in the Euro 4 step.

Each subcategory will only be subject to a single test procedure. Annex VI (C2) of Regulation168/2013 contains limits for permeation and SHED tests in anticipation of the decision on the applicable test procedure (i.e. the permeation or SHED test).

Respondents were asked which test procedure (permeation test procedure or SHED) is the most beneficial for selected L-category vehicles (i.e. L1e, L2e, L5e-B, L6e-B, L7e-B

and L7e-C). The majority (72-73%) answered 'Don't Know' while the rest were equally split between permeation test and SHED for each vehicle category (13-15%).

With regard to the SHED test limit, respondents were asked whether it was justified to lower the limit form 2000 to 1500 mg/test for selected sub-categories (i.e. L3e, L4e, L5e-A and L7e-A) that are already subject to SHED testing (as of Euro 2016) to better balance the fuel storage tank, fuel delivery system dimensions and the limit.

The majority (58-62%) answered 'Don't Know' for each sub-category. Again those who answered 'Yes' and 'No' were equally split (20-21%).

Respondents were also asked whether they expected a Euro 5 SHED test complaint vehicle needed to be equipped with additional/modified hardware (e.g. carbon canister/dimensional change). The majority (57%) of respondents answered 'Don't Know' followed by 34% who answered 'Yes' and 8.5% who answered 'No'.

Those who answered 'Yes' gave the following reasons:

- all terrain and special service vehicles have currently no SHED provision
- measures may have to be taken to meet the requirement change
- L7e-B vehicles will require a carbon canister, purge valve, hose routing to the engine and software modifications to the ECU
- need to change to lower permeation materials/better sealing.

In contrast, those who answered 'No' made the following points:

- No for L3, L4, L5e-A and L7e-A but may be necessary for other categories.
- No modification if no change in the evaporative limits.

3.9 Type V: Durability of Pollution Control Devices

Article 23, Paragraph 3 of Regulation 168/2013 describes three possible methods that manufacturers can choose to ensure that type-approval durability requirements are met:

(a) actual durability testing with full mileage accumulation;
(b) actual durability testing with partial mileage accumulation;
(c) mathematical durability procedure.

There are two durability distance accumulation test cycle alternatives available (see Figure 6):

- Method (a) Approved Mileage Accumulation (AMA)

- Method (b) Standard Road Cycle (SRC) -LeCV cycles.

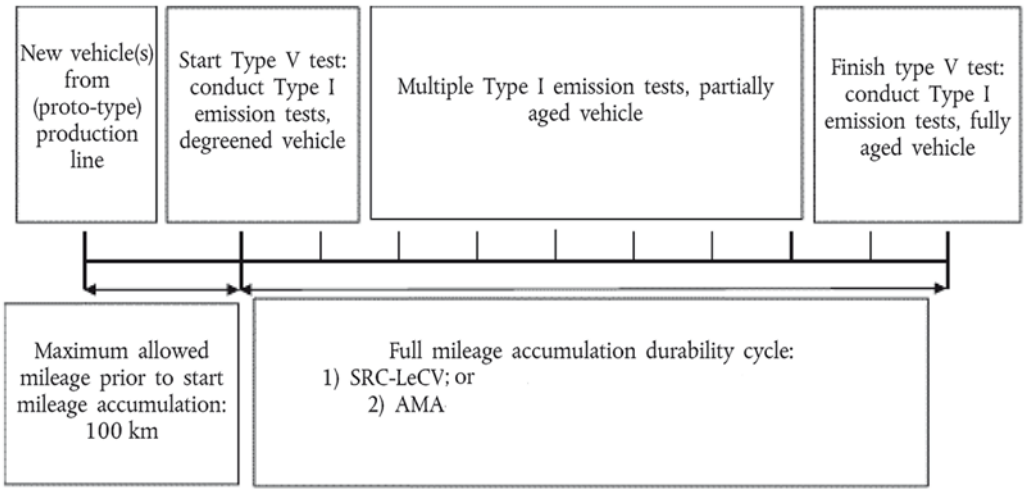
The EU considers the AMA test cycle to be obsolete. Its application has been tolerated only for the sake of worldwide harmonization.

The other durability cycle, SRC-LeCV, focuses on operating modes and real-world after-treatment ageing.

On average this cycle can be conducted twice as fast in comparison to the AMA cycle, resulting in significant lower costs and providing more flexibility for manufacturers. However, the SRC-LeV replicates the global average driving conditions (WMTC engine speed and load points) and is more challenging in comparison to the AMA cycle. The AMA cycle was developed for passenger cars in the 1970s in the era before vehicles were equipped with pollution control devices.

The SRC-LeV is in fact a set of four different cycles applicable to different L-vehicle categories depending on the same classification criteria as for Test type I (power and max design vehicle speed).

Test type V – durability test procedure with full distance accumulation



Test type V – accelerated durability test procedure with partial distance accumulation

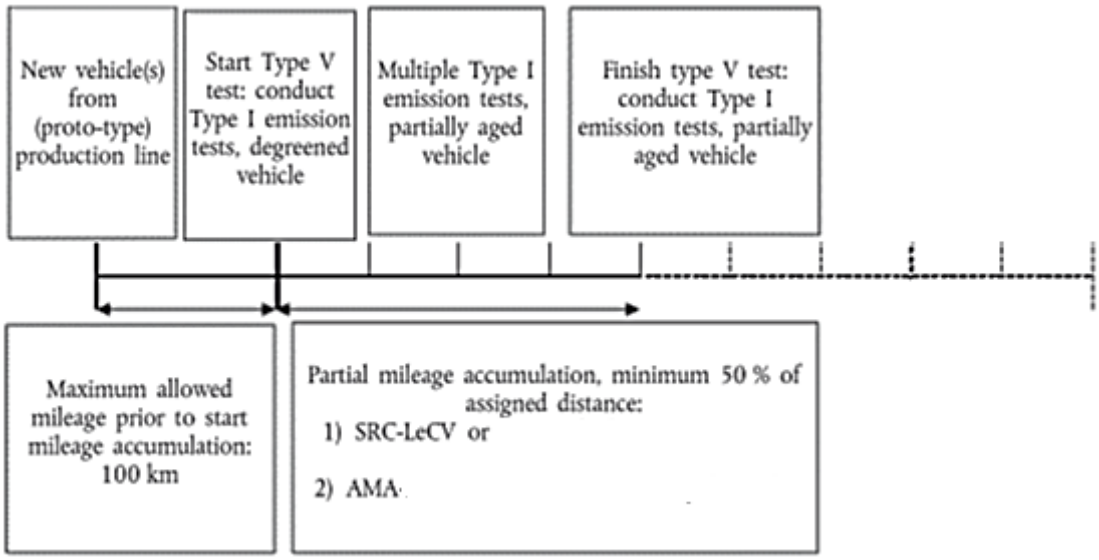


Figure 6: Test Type V - Durability

Figure 7 below presents the Euro 5 total hydrocarbon (THC) limit value, emissions calculated with the deterioration factor, mathematical method (c), and two possible cases where emissions are actually above the limit after 10,000 km and 40,000 km accumulated distance.

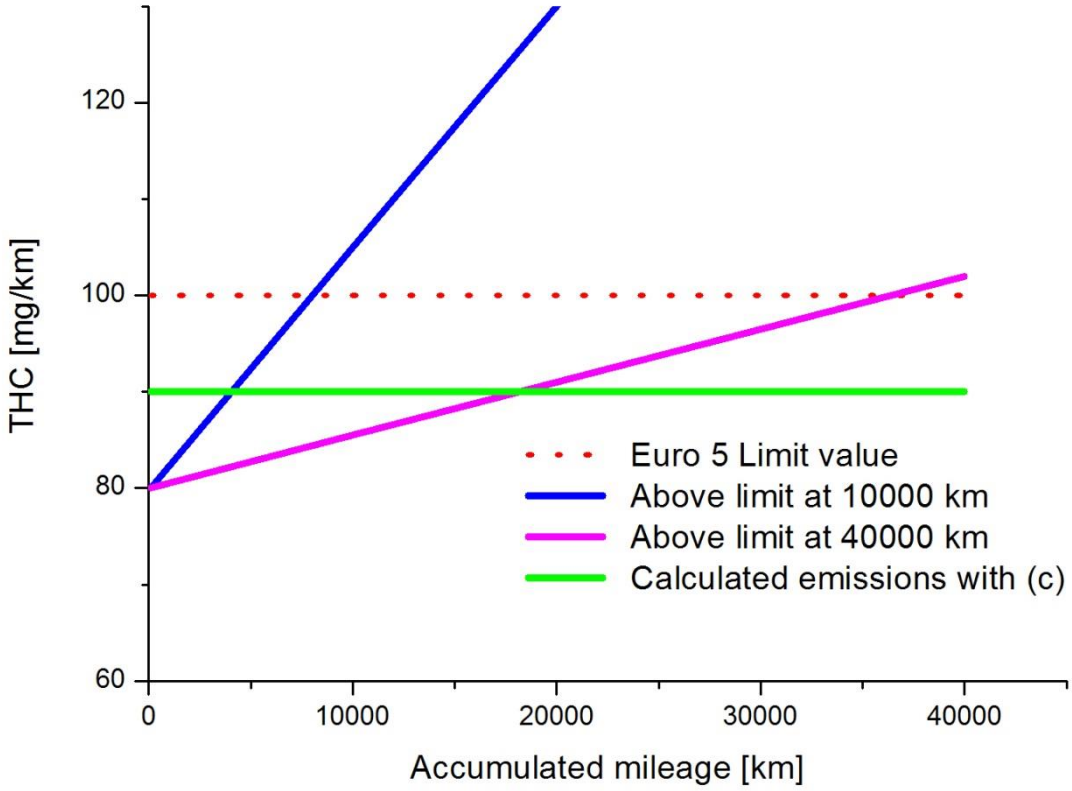


Figure 7: Euro 5 Total Hydrocarbon Limit

Respondents were presented with the above example and asked whether they thought the mathematical method is effective compared to methods (a) and (b) mentioned above. The majority of respondents (49%) answered 'Don't Know' followed by 33% who stated 'No' compared to 18% who stated 'Yes'.

Those answered 'No' raised the following issues:

- Modelling of complex items is a simplification and does not provide robust evidence of what happens over the lifetime of a vehicle.
- It is better to measure real emissions. Most models are limited. For example, a mathematical model does not take into account how emissions change when using cleaner fuels.
- Mathematical modelling is not representative for a vehicle failing at 10000 km
- Real-world emission behaviour is too complex for a mathematical model
- High uncertainty
- While reputable manufacturers will ensure durable emissions control solutions even with fixed deterioration factors, it cannot prevent cheap imports equipped with non-durable systems to enter the market.
- Calculated emissions do not consider the wear and tear of the engine.

In addition, respondents were asked whether they thought the deterioration rates laid down in Annex VII (B) of Regulation 168/2013 are appropriate and should be maintained or revisited beyond the Euro 5 step.

The majority (51%) of respondents answered 'Don't Know' followed by 30% who felt the deterioration rates should be revisited beyond the Euro 5 Step and 19% who felt the rates were already appropriate and should be maintained.

Those who stated that deterioration rates should be revisited beyond the Euro 5 step suggested this was necessary in order to reflect what happens under real-world conditions and to take into consideration advances in vehicle technology. In addition, there should be greater focus on factors such as the effect of cleaner fuel use on the ageing of vehicles.

Respondents were asked to consider whether it is justified to phase-out the AMA distance accumulation test cycle as an alternative Euro 5 step (after 2020), taking into consideration pros and cons (i.e. international harmonisation vs. highly questionable effectiveness).

The majority (58%) answered 'Don't Know' followed by 23% who answered 'Yes' and 19% who answered 'No'.

Respondents who answered 'Yes' felt the test cycle was already obsolete while those answered 'No' stated that the AMA cycle is used worldwide and is proven to be efficient.

In the negotiations before adopting Regulation 168/2013, the initial proposal of a 50,000 km distance accumulation (10 years life of a motorcycle X 5000 km average distance accumulation) for the Euro 5 step was lowered for an L3e-A3 motorcycle (>35 kW) and set equal to the Euro 4 distance (35,000 km), initially proposed for an L3e-A2 motorcycle (medium power between 11 and 35 kW power).

Respondents were asked whether they agreed that the distance should be increased for an L3e-A3 motorcycle to a representative 50,000 km for such a motorcycle type beyond the Euro 5 step (after 2020).

The majority (45%) answered 'Don't Know' followed by 30% who answered 'Yes' and 25.5% who answered 'No'.

These who answered 'Yes' felt 50,000 km was not too much for a L3e-A3 motorcycle for they would reach such mileage over the vehicle life and these vehicles will be driven greater distances than lower powered vehicles. It was therefore practical to apply the same distance for all categories.

Those respondents who answered 'No' felt annual mileage does not depend on vehicle technology.

3.10 Type VII: Energy Efficiency Test

Energy efficiency means testing the fuel/energy consumption, CO_2 emissions and electric range for L-category vehicles equipped with a conventional combustion engine, a hybrid electric powertrain (energy consumption and electric range) or for a pure electric vehicle (energy consumption and electric range).

Article 24 (1) of Regulation 168/2013 states that CO_2 emissions shall be determined in the applicable laboratory emission test cycle by the manufacturer and reported by the manufacturer to the approval authority and to the consumer at point of sale.

The intention of Test type VII is to measure the energy efficiency in a harmonised and objective way and to make this information available to the consumer at point of sale.

Respondents were asked what technologies have the highest potential for improving the fuel efficiency of L-category vehicles and provided the following answers:

- alternative fuels
- ultra-pure synthetic fuels for L-vehicles with combustion engines

- battery technology
- gas recirculation
- improved engine thermodynamics
- weight reduction
- internal engine reduction
- optimised fuel injection
- friction optimization
- optimized aerodynamic
- intelligent transmission
- mild hybridization.

3.11 Functional On-board Diagnostic and Type VIII Environmental On-board Diagnostic Test

The main objective of on-board diagnostics (OBD) is to ensure effective and efficient vehicle repair. In addition, many of the OBD features have beneficial secondary effects on environmental protection and vehicle functional safety.

An objective of the Euro 5 regulation is to ensure the full and non-discriminatory access to vehicle on-board data and the diagnostic information. This is to be used as a key input in vehicle repair and maintenance and to level the playing field among authorised and independent repairers. It is intended to increase competition and lower repair and maintenance cost of L-category vehicles.

Respondents were asked what they considered were the advantages of enhanced OBD requirements compared to basic requirements introduced in the Euro 4 step for L-category vehicles (see Table 7).

The top three advantages were:

1. better diagnostic quality information to the repairer - making repairs more effective and efficient
2. enhanced functional safety requirements (e.g. fast warning/notification enhanced default modes protecting rider and vehicle)
3. reduction of repair costs to user owing to more effective and efficient repair of complex powertrain technology and increased competition between authorised and independent repairer.

The top three disadvantages were (see Table 8):

1. increased vehicle cost passed on to the consumer
2. longer vehicle development, production and system complexity
3. increased research and development investments to deal with legal requirements.

Respondents were asked what were the environmental benefits of OBD stage II. The majority (35.5%) stated catalysts diagnostics followed by oxygen response (19%) and more advanced electric circuit diagnostics (10%).

Table 7: Advantages of On-Board Diagnostics

What do you consider are the advantages of enhanced on-board diagnostic requirements compared to the basic requirements introduced in the Euro 4 step for L-category vehicles?		
Answer Options	**Response Percent**	**Response Count**
Better diagnostic quality information to the repairer - making repairs more effective and efficient	90.3%	28
Reduction of repair costs to user owing to more effective and efficient repair of complex powertrain technology and increased competition between authorised and independent repairer	32.3%	10
Enhanced functional safety requirements (e.g. fast warning/notification enhanced default modes protecting rider and vehicle)	38.7%	12
Improved component/safety/production quality without increase of cost to end consumer owing to increased competition between vehicle manufacturers	3.2%	1
Increased innovation in vehicle environmental and functional safety performance features	25.8%	8
Increased export of technology and intellectual property to non-EU, global markets which follow EU legislation	22.6%	7
	answered question	**31**
	skipped question	**32**

The respondents made the following comments:

- The benefit of having these additional types of monitoring (e.g. catalyst) depends on the size of real world malfunctions (occurrence and excess emission level). It therefore can only be beneficial if the necessity is proven and if benefits exceed costs.
- All options listed are likely to occur.
- The environmental benefits are significant for these vehicles as was the case for automobiles and heavy-duty vehicles. Information about the installed technology is known by the vehicle manufacturer at the time of design. It is at this point where the appropriate OBD functions can be installed to verify the proper operation of emission-related components/systems.

3.12 Off-Cycle Emissions and Energy Efficiency Determination

The Euro 5 environmental effects study should, *inter alia*, assess the feasibility and cost-effectiveness of in-service conformity testing requirements, off-cycle emission requirements and a PN limit for certain (sub-) categories.

On the basis of the environmental effects study, the Commission should consider a proposal to introduce new elements into future type-approval legislation applicable after the Euro 5environmental step.

Concerning "off-cycle emission requirements", it is envisaged that an engine should be clean and energy efficient both when tested in legislative driving cycles and under real-world conditions not captured in the legislative test cycle.

Figure 8 below was obtained from a manual transmission motorcycle (L3e-A3) on a chassis dynamometer. It shows power versus engine speed within the WMTC, the R40

driving cycle (UNECE- Regulation No. 40) and at wide open throttle performance to show the ultimate boundary of feasible engine operation.

The hatched part-load area consists of feasible part-load points which may be covered by the engine under real-word driving conditions but are not sampled during the R40 or WMTC tailpipe emission tests.

Table 8: Disadvantages of On-Board Diagnostics

What do you consider are the disadvantages of enhanced on-board diagnostic requirements compared to the basic requirement introduced in the Euro 4 step for L-category vehicles?		
Answer Options	**Response Percent**	**Response Count**
Longer vehicle development, production and system complexity	62.5%	20
Increase vehicle cost passed on to the consumer	75.0%	24
Additional warranty cost	31.3%	10
Risk of loss of reputation of the vehicle manufacturer/repairer owing to quality problems that could be emerging as a result of an enhanced on-board diagnostic system	12.5%	4
Increase research and development investments to deal with legal requirements	37.5%	12
Not technically feasible - new technologies need to be developed	18.8%	6
Perception by consumers based on experience with car legislation: on-board diagnostic is only an environmental protection feature and not willing to pay for this additional functionality	21.9%	7
	answered question	**32**
	skipped question	**31**

Respondents were asked what they thought about future off-cycle emission requirements and whether they was a need to prevent the optimisation of the environmental performance of the vehicle to pass only the test type approval cycle.

The majority (54.5%) answered 'Yes' while the rest were evenly split between 'No' and 'Don't Know') at 12%.

The following comments were made:

- No justification for vehicle with power and speed limitation.
- Only after the introduction of off-cycle emission requirements on light duty vehicles.
- The frequency of use of an L-category vehicle outside the test cycle has not been demonstrated or proven. Therefore an off-cycle test cannot be justified.
- Emission reductions under real-world driving conditions are important for the credibility of the industry. Studying the real-world performance of L-category vehicles and, if necessary, work on improving dialogue with the industry seems appropriate. Technological developments as well as lead time for the industry should be taken into account.
- Yes, off-cycle emissions are a key element of emission legislation.

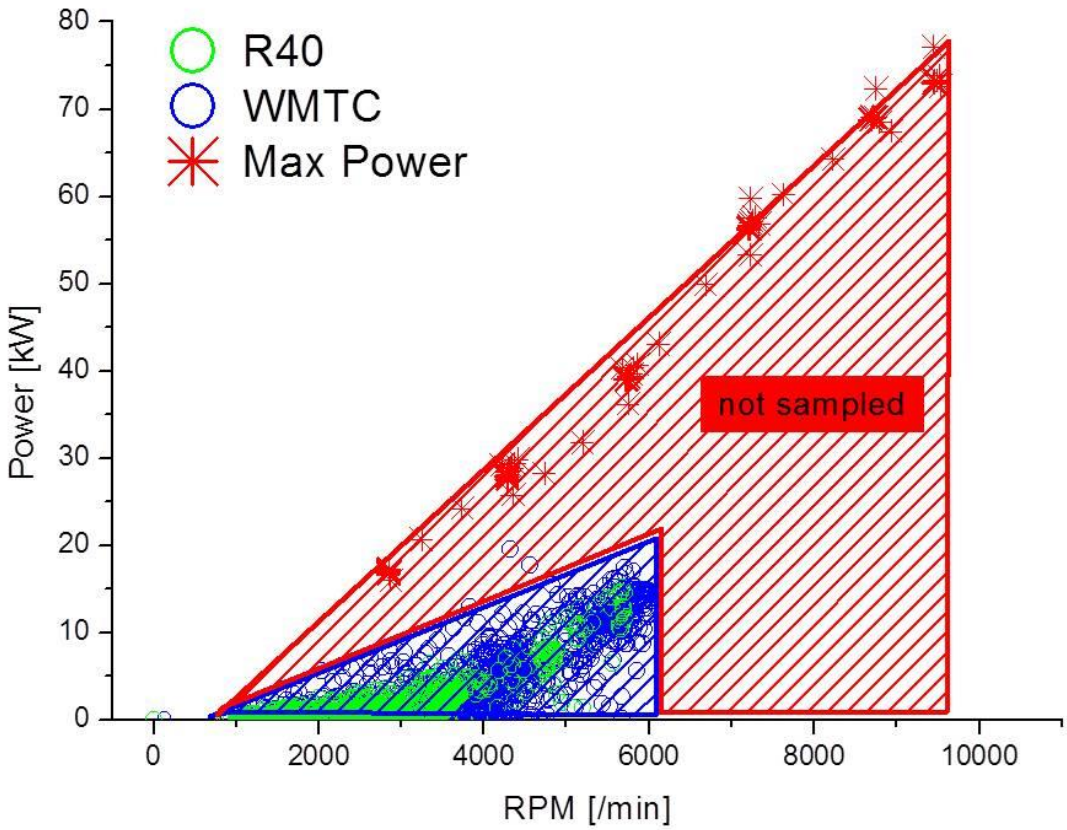


Figure 8: Power Versus Engine Speed with the WMTC

Respondents were then asked if they thought a particular procedure should be followed to obtain reliable off-cycle emission and energy efficiency data for L-category vehicles, made obligatory in approval legislation beyond 2020.

A total of 43% of respondents answered 'Yes' while 30% answered 'No' and 27% did not know.

With regard to the chassis dynamometer tests, respondents were asked whether this was the correct approach to obtain off-cycle information for L-category vehicles. The responses were equally split at 35.5% between 'Yes' and 'Don't Know' followed by 'No' (29%).

Those who answered 'Yes' made the point that random cycle(s) on a chassis dyno could be carried out but questioned whether it still relevant for vehicle speed limited vehicles. In contrast, those who answered 'No' made the following comments:

- On-board measurement using portable emission monitoring systems (PEMS) without no connection to the OBD is likely to be the best way forward.
- Miniaturization of the PEMS equipment is under way and shall be ready for L-category vehicle measurement.
- Potentially PEMS could be used on larger vehicles.
- Real-world driving emissions can be a good solution if the size and weight of the test equipment significantly decreases beyond 2020 and experience of light duty vehicles demonstrates its applicability.

- According to Regulation 168/2013, L7e-B vehicles are limited by design to 90 km/h (L7e-B1) or to 15 kW (L7e-B2), falling therefore automatically under the "sampled part" of both R40 and WTMC. "Off-cycle" emissions are therefore irrelevant for this category.
- Hand costs for mobile equipment (and how to transport it on a moped) and restricted comparability between real life and dynamometer are issues.

Finally, respondents were asked if there were any further technical feasibility issues that should be investigated with regard to the application of Euro 5 requirements to L-category vehicles.

Comments made included:

- impact of fuels.
- the technical feasibility of OBD-II catalyst monitoring, and misfire detection.
- Standard battery packages for L-category vehicles should be investigated to ease the removal and replacement of batteries.
- HC, NO_2, soot (not "particles" in general), tar and toxic when the L-vehicles use ultra-clean fuels.
- Ultra-clean fuels (e.g. Alkylate gasoline for otto engines (SI engines), gas-to-liquid (GTL) fuels and hydrotreated vegetable oil (HVO) fuels for compression ignition (diesel) engines). Especially since conventional petrol should contain ethanol and diesel fuel should contain Rapeseed Methyl Ester/Fatty-Acid Methyl Ester (RME/FAME)). These compounds could cause technical problems, especially in L-category vehicles. Therefore other types of fuels, free of ethanol and RME/FAME should be used.

4. Conclusions

The aim of the on-line questionnaire survey was to gather public opinions on the adoption of the Euro 5 Limit for L-category vehicles. Although the response rate was low at 5%, the results of the survey provide some insight into the views held by a cross-section of stakeholders on this subject. The EU L-category vehicle fleet is expected to increase over the next five years for L1e-powered cycles and L3e two-wheel motorcycles.

Overall the implementation of the Euro 5 environmental performance requirements is seen as having environmental and health benefits in terms of reduced emissions levels. However, some fear that this measure will increase production and vehicle costs. In particular, some respondents question whether the WMTC is representative of real-world engine conditions for L-category vehicles.

The key findings of this survey are summarized below:

1. **Type I – Tailpipe Emission Tests After Cold Start**
In general, it is technically feasible to comply with Euro 5 limits for HCs, NOx, CO using existing technologies. However, there is a general uncertainty on whether the PM limits can be met. There are additional technical challenges (e.g. use of post-treatment technology) with costs estimated to be €101-200 for L1e (light-two wheeled vehicle and L2e (three-wheeled moped) and €201-300 for L7e B (heavy all terrain quads) and L7e-C (heavy quadri mobile). In addition, ethanol in fuel is expected to affect Test IV evaporative emission testing and leading to canister deterioration.

2. **Type III – Emissions of Crankcase Gases**
Unburnt crankcase gas emissions are considered a threat to human health and environment but there is uncertainty whether crankcase emissions are higher than tailpipe emissions. In addition, there is uncertainty on whether inefficient operating crankcase systems have a damaging effect on engine life and whether the verification method for the crankcase ventilation system is appropriate and beneficial.

3. **Type IV Evaporative Emissions**
There is a general uncertainty on whether the fuel permeation test and lower SHED test limit are appropriate for L-category vehicles or whether Euro 5 SHED test complaint vehicles need additional/modified hardware.

4. **Type V Durability of Pollution Control Devices**
There is a general uncertainty about the most appropriate type-approval durability test, whether AMA cycle should be phased-out and whether an increase in distance accumulation for L3e–A motorcycle is justified.

5. **Type VII Energy Efficiency Test**
A range of technologies have the potential to improve fuel efficiency of L-category vehicles (e.g. alternative fuels, battery technology, gas recirculation, intelligent transmission).

6. **Functional on-board diagnostics and Type VIII environmental On-Board Diagnostic test**
OBD is seen as providing better diagnostic quality information to the repairer, enhanced functional safety requirements and reduced repair costs to users. However, there may be increased vehicle costs for consumers, longer vehicle development and production and increased research and development efforts.

7. Off-Cycle Emissions and Energy Efficiency Determination

It is generally considered that future off-cycle emission requirements should prevent the optimisation of the environmental performance of the vehicle to pass only the test type approval cycles and test procedures. An obligatory procedure should be followed to obtain reliable off-cycle emission and energy efficiency data for L-category vehicles. Chassis dynamometer tests can be used to obtain off-cycle information. However, the impact of alternative fuels, technical feasibility of OBD stage II, standard battery package and an HC limit for off-cycle emissions require further investigation.

In conclusion, it can be seen from the survey results that there is general uncertainty about specific aspects of adopting the Euro 5 step for L-category vehicles. According to the stakeholders, the environmental effects study should therefore provide further analysis and clarifications on the following questions:[3]

- Does the WTMC represent real-world engine conditions for L-category vehicles?
- Can L-category vehicles adapted for technical progress meet the PM and PN limits?
- How significant are crankcase emissions?
- What effect do crankcase emissions have on the engine?
- What verification method can be used to assess crankcase emissions?
- Can the fuel permeation test be applied to certain type of L-category vehicles?
- What is the most appropriate durability test for L-category vehicles?
- What is the impact of alternative fuels, OBD stage II, standard battery package and an HC limit on off-cycle emissions on L-category vehicles?

[3] **Disclaimer:** only some of these stakeholders questions will be addressed in the environmental effects study, others are outside the scope or not relevant.

List of abbreviations and definitions

AMA	Approved Mileage Accumulation
ATV	All-terrain vehicle
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
DG	Directorate General
DI	Direct injection
DOC	Diesel oxidation catalyst
DPF	Diesel particulate filter
EC	European Commission
ECU	Engine control unit
EGR	Engine gas recirculation
EU	European Union
FAME	Fatty-acid methyl ester
GHG	Greenhouse gas
GPF	Gasoline particulate filter
GTL	Gas-to-liquid
HVO	Hydrotreated vegetable oil
LDC	Light duty vehicle
LPG	Liquid petroleum gas
HC	Hydrocarbon
JRC	Joint Research Centre
NGO	Non-governmental organisation
NMHC	Non-methane hydrocarbons
NO_x	Nitrogen oxides
O_3	Ozone
OBD	On-board diagnostics
PAH	Polycyclic aromatic hydrocarbons
PEMS	Portable emission monitoring system
PM	Particulate matter
PN	Particulate number
PTW	Powered- two-wheeler
SbS	Side-by-side
SHED	Sealed Housing for Evaporative Determination
SRC	Standard road cycle
RME	Rapeseed methyl ester
THC	Total hydrocarbons
UNECE	United Nations Economic Commission for Europe
UNECE/EPPR	UNECE Environmental and Propulsion Performance Requirements of L-category vehicles informal working group
WMTC	World Motorcycle Test Cycle

List of figures

List of tables

Annex I - Questionnaire Survey

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

INTRODUCTION

Survey Period

SURVEY PERIOD EXTENDED TO FRIDAY 10 JULY 2015

From 30 March 2015 to 8 May 2015.

If you would like a pdf version of the questionnaire survey to preview please email theJRC.

Policy Field(s)

Transport vehicle, regulations, type approval, L-category vehicles*

*** L-category is the family name of light vehicles such as powered cycles, two- and three-wheeled mopeds, two-wheeled motorcycles with and without a side car, tricycles and quadricycles.**

Objective of the Survey

The objective of this survey is to seek views on the impact of Euro 5 environmental step on L-category vehicles with regard to benefits, costs and technical feasibility.

BACKGROUND

The European Commission's Joint Research Centre (JRC) is undertaking this questionnaire survey as a contribution to a comprehensive study on the environmental effects of Euro 5 L-category vehicles required by Regulation (EU) No 168/2013.

Regulation (EU) No 168/2013 supplemented withRegulation (EU) No 134/2014 outline harmonised rules for the type approval of L-category vehicles consisting of two steps. The Euro 4 (new types: 2016) and Euro 5 (new types: 2020) steps for L-category vehicles assist in improving (urban) air quality by reducing the share of pollutant emissions emitted by L-category vehicles.

The 2009 impact assessment conducted prior to the adoption of Regulation EU No 168/2013 concluded that mopeds and light motorcycles emit disproportionately high hydrocarbon levels compared to other modes of road transport (e.g. cars, trucks and buses). However, the impact assessment considered only the application of the the Euro 4 step to L-category vehicles.

The 'Euro 5 environmental step' contains a package of measures designed to reduce particulate matter and ozone precursors such as nitrogen oxides and hydrocarbons. Before applying the Euro 5 step, the European Council and European Parliament requested the Commission to undertake an environmental effects study of the Euro 5 step already set out in Regulation (EU) No 168/2013 and Regulation (EU) No 134/2014.

The results of this on-line stakeholder survey will provide an input to the environmental effects study and will support the European Commission in undertaking the final assessment of the Euro 5 step requirements.

How to Submit Your Contribution

We welcome contributions in English from operational stakeholders active in the L-category vehicle industry (i.e. original equipment manufacturers (OEM) and suppliers, etc) and to organisations, bodies, user groups and public administrations related to the L-category vehicle sector as well as interested citizens.

The survey consists of 40 questions and should take 30-40 minutes to complete. If you are unable to answer any question please tick 'Don't know.'

Thank you for your cooperation.

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Your Organisation

We would like to know a little more about you.

* 1. Personal details

Your Name

Your organisation (PLEASE COMPLETE THIS QUESTION!)

Address 1:

Address 2:

City/Town:

State/Province:

ZIP/Postal Code:

Country:

Email Address:

Phone Number:

* 2. How would you define your organisation? PLEASE COMPLETE THIS QUESTION!

- Policy maker on environmental requirements
- Industry (e.g. manufacturer) or industry representative
- Type Approval Authority (TAA)
- Technical Services Provider *
- Other governmental organisation, not one of the types mentioned above
- Rider or user association
- Individual citizen
- Other

Please specify.

** An organisation or body designated by the approval authority of a Member State as a testing laboratory to carry out tests, or as a conformity assessment body to undertake the initial assessment and other tests or inspections, on behalf of the approval authority.*

3. Which type of vehicles below does your organisation deal with? (Select those most appropriate, more than one can be ticked)

- [ ] L1e-A Powered cycle
- [ ] L1e-B Two-wheel moped
- [ ] L2e Three-wheel moped
- [ ] L3e Two-wheel motorcycle
- [ ] L4e Two-wheel motorcycle with side-car
- [ ] L5e-A Tricycle
- [ ] L5e-B Commercial tricycle
- [ ] L6e-A Light on-road quad
- [ ] L6e-B Light quadri-mobile
- [ ] L7e-A Heavy on-road quad
- [ ] L7e-B Heavy all terrain quad
- [ ] L7e-C Heavy quadri-mobile
- [ ] Other (please specify) _____

L-Category Vehicles*

L1e		L2e	L3e	L4e	L5		L6e		L7e		
Light two-wheeled vehicle		*Three-wheel moped*	*Motorcycle*	*Motorcycle with side car*	*Tricycles*		*Light quadricycle*		*Heavy qudricycle*		
L1e-A *Powered cycles*	**L1e-B** *Moped*	**L2e**	**L3e**	**L4e**	**L5e-A** *Tricycles*	**L5e-B** *Commercial tricycles*	**L6e-A** *Light quad*	**L6e-A** *Light mini car*	**L7e-A** *On-road quad*	**L7e-B** *Heavy all terrain quad*	**L7e-C** *Heavy Quad mobile*
		 L2e-P	 L3e-A1	 L4e-A1				 L6Be-P	 L7e-A1	 L7e-B1	 L7e-CU
		 L2e-U	 L3e-A2	L4e-A2				 L6Be-U	 L7e-A2	 L7e-B2	 L7e-CP
			 L3e-A3	L4e-A3							
≤50cc, ≤25 km/h, <4 kW, C O 25kmh, 250 W continuous rated or net power ≤1000 W	≤50cc, ≤45 km/h, <4 kW	≤50cc, ≤45 km/h, <4 kW, ≤270 kg	<= 11 kW, A2: <=35 kW		3W, <1000 kg,	3W, <1000 kg, max 2 seats, V 0.6m^3	<4kW, ≤425 kg, ≤45 km/h (D, G)	<6kW, <425 kg, ≤45 km/h (D, G)	<15kW, ≤450 kg	W/G<6, ≤450 kg	P: ≤450 kg, U: ≤600 kg, (D, G)

* **Disclaimer:** This table is only indicative of the classification criteria. For a comprehensive list please see Annex I of EU Regulation 168/2013)

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Euro 5 Environmental Step

4. How do you see the development of the L-category vehicle fleet as a share of the total EU transport fleet over the next 5 years?

For example, in 2012 L-category vehicles represented 8-23% of total vehicle fleet in the EU: Germany (8%), Greece (23%) Italy (13%), Spain (9%) (Eurostat, 2015).

	Increase	Stay the same	Decrease	Don't Know
L1e-A Powered cycle	○	○	○	○
L1e-B Two-wheel moped	○	○	○	○
L2e Three-wheel moped	○	○	○	○
L3e Two-wheel motorcycle	○	○	○	○
L4e Two-wheel motorcycle with side-car	○	○	○	○
L5e-A Tricycle	○	○	○	○
L5e-B Commercial tricycle	○	○	○	○
L6e-A Light on-road quad	○	○	○	○
L6e-B Light quadri-mobile	○	○	○	○
L7e-A Heavy on-road quad	○	○	○	○
L7e-B Heavy all terrain quad	○	○	○	○
L7e-C Heavy quadri-mobile	○	○	○	○

Other (please specify)

5. What do you consider are the general advantages of implementing the Euro 5 environmental step on L-category vehicle at the European level? (*More than one can be selected*)

- [ ] Reduced pollutant emissions
- [ ] Increased energy efficiency (e.g. consuming less fuel per 100 km, increased range)
- [ ] Public health
- [ ] Increased efficiency and effectiveness of vehicle repair by enhancing on-board diagnostic capability
- [ ] Innovation
- [ ] Technological leadership
- [ ] Decreased carbon dioxide emissions and other greenhouse gases
- [ ] Competitive advantage in the EU market or exporting technologies outside the EU

Other (please specify)

6. What do you consider are the general disadvantages of implementing the Euro 5 environmental step on L-category vehicles at the European level? (*More than one can be selected*)

- [ ] Increased production costs
- [ ] Decreased energy efficiency (e.g. consuming less fuel per 100 km, increased range)
- [ ] Significant vehicle price increase due to on-board diagnostic capability stage 2
- [ ] Increased carbon dioxide emissions and other greenhouse gases
- [ ] Decreased product reliability
- [ ] Decreased user friendliness of products
- [ ] Decreased sales
- [ ] Technically challenging

Other (please specify)

7. What are the main advantages of L-category vehicle use? (More than one can be selected)

- [ ] Reduced polluting air emissions
- [ ] Reduced congestion
- [ ] Economical to run
- [ ] Fuel efficient system
- [ ] Provides greater accessibility/parking options
- [ ] Other (please specify)

8. What are the main disadvantages of L-category vehicle use? (More than one can be selected)

- [ ] Increased air pollution
- [ ] Increased noise pollution
- [ ] Odour pollution
- [ ] Increased vulnerability of users on the road
- [ ] Other (please specify)

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Environmental Performance Test Types

<u>Regulation EU No 168/2013</u> requires the following test types for different L-category vehicles.

Environmental Performance Tests and Requirements

(A) Environmental tests and requirements

L-category vehicles may be type-approved only if they comply with the following environmental requirements:

Test type	Description	Requirements: limit values	Subclassification criteria in addition to Article 2 and Annex I	Requirements: test procedures
I	Tailpipe emissions after cold start	Annex VI (A)	UNECE global technical regulation No 2, Chapter 6.3. L-category vehicles equipped with a combustion engine having a displacement < 50 cm^3 and travelling with v_{max} < 50 km/h shall be attributed to class 1 vehicles	
II	— PI or Hybrid ([7]) equipped with PI emissions at idling and increased idling speed — CI or Hybrid with CI engine: free acceleration test	Directive 2009/40/EC ([8])		
III	Emissions of crankcase gases	Zero emission, closed crankcase. Crankcase emissions shall not be discharged directly into the ambient atmosphere from any vehicle throughout its useful life.		
IV	Evaporative emissions	Annex VI (C)		
V	Durability of pollution control devices	Annexes VI and VII		
VI	A test-type VI has not been attributed	Not applicable		Not applicable
VII	CO_2 emissions, fuel and/or electric energy consumption and electric range	Measurement and reporting, no limit value for type-approval purposes	UNECE global technical regulation No 2, Chapter 6.3. L-category vehicles equipped with a combustion engine having a displacement < 50 cm^3 and travelling with v_{max} < 50 km/h shall be attributed to class 1 vehicles	
VIII	OBD environmental tests	Annex VI (B)	UNECE global technical regulation No 2, Chapter 6.3. L-category vehicles equipped with a combustion engine having a displacement < 50 cm^3 and travelling with v_{max} < 50 km/h shall be attributed to class 1 vehicles	
IX	Sound level	Annex VI (D)	When UNECE regulations Nos 9, 41, 63 or 92 replace the EU proprietary requirements set out in the delegated act on environmental and propulsion performance requirements, the (sub-) classification criteria laid down in those UNECE regulations (Annex 6) shall be selected with reference to test type IX sound level tests	

NB: Test type IX, sound requirements, is not part of the environmental effects study. A dedicated study will be conducted in due course.

The following section will ask questions about each test type covered in the regulation:

Type I: Tailpipe emissions after cold start

Type III: Emissions of crankcase gases

Type IV: Evaporative emissions

Type V: Durability of pollution control devices

Type VII: Energy efficiency (CO2 emissions, fuel or energy consumption, range)

Type VIII: Functional on-board diagnostics (effective and efficient vehicle repair) and test type VIII (environmental OBD verification test)

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type I -Tailpipe emissions tests after cold start

The Euro 5 environmental step extends the use of the WMTC (Worldwide harmonized motorcycle test cycle) to mopeds (L1 and L2 category) and to 3 and 4-wheelers as current test cycles (UNECE R40 and R47) are deemed obsolete and not representative of modern traffic behaviour.

A revised 'WMTC' procedure (see Figure below) is being proposed at Euro 5 level to cover other L-vehicle categories. This change applies to all tailpipe related testing: test types I, V, VII and VIII. The WMTC for motorcycles in the Euro 5 step remains unchanged and is harmonised around the world.

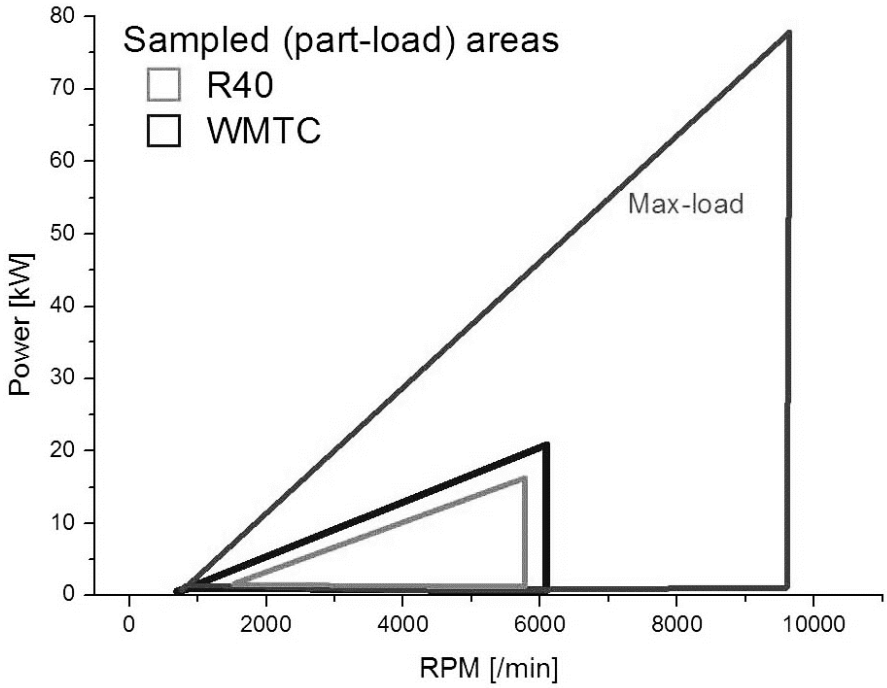
The main objective of any emission test-cycle performed in a laboratory is to provide a comprehensive assessment of tailpipe emissions in the **part-load area** (i.e. the area below the power-torque curve covered by the WMTC) by maximizing quality, quantity and dynamics of emission sampling within an assumed part-load area.

1. **Quality:** distribution of emission sampling within the specified part-load area of testing determined by the engine speed and engine load boundaries of this area.

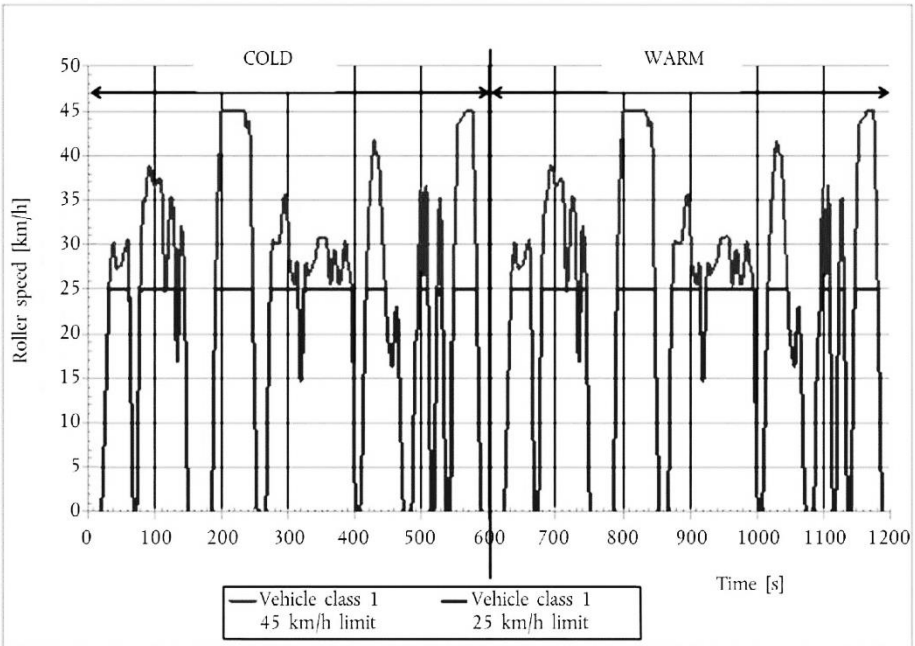
Indicators:
a) Covered part-load area (sampling distribution)
b) Drive-ability: statistics on driver violations (actual vehicle speed vs desired vehicle speed on driver aid) during the test in terms of violation time compared to total test time and the amount of driver violations per test.

2. **Quantity**: intensity of part-load area sampling, number of samples per engine speed and engine load matrix point.

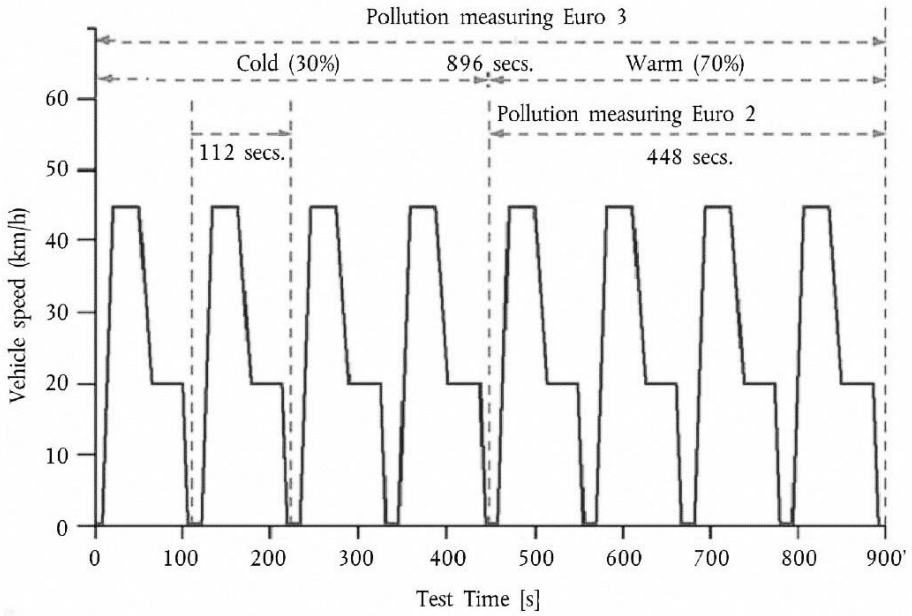
3. **Dynamics**: statistics on the slope of "jumps" between the various engine speed and engine load matrix points within the covered part-load area of tailpipe emissions sampling within the Type I tailpipe emissions laboratory test (expressed in delta engine speed and/or engine load per second).



WMTC stage 3 for L1e-A, L1e-B, L2e, L5e-B, L6e-A and L6e-B vehicles. The truncated vehicle speed trace limited to 25 km/h is applicable for L1e-A and L1e-B vehicles with a limited maximum design vehicle speed of 25 km/h



Pollutant emission sampling for Euro 3 as compared with Euro 2 for an L1e, L2e or L6e category vehicle



9. Do you think the WMTC is representative of real-world engine operating conditions for L-category vehicles?

	Yes	No	Don't Know
L1e-A Powered cycle	○	○	○
L1e-B Two-wheel moped	○	○	○
L2e Three-wheel moped	○	○	○
L3e Two-wheel motorcycle	○	○	○
L4e Two-wheel motorcycle with side-car	○	○	○
L5e-A Tricycle	○	○	○
L5e-B Commercial tricycle	○	○	○
L6e-A Light on-road quad	○	○	○
L7e-A Heavy on-road quad	○	○	○
L7e-B Heavy all terrain quad	○	○	○
L7e-C Heavy quadri-mobile	○	○	○

Other (please specify)

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type I -Tailpipe emissions tests after cold start

Regulation EU No 168/2013 proposes Euro 5 emission limits for new types of L-category vehicles from 1 January 2020.

Euro 5 Emission Limits

(A2) Euro 5

Vehicle category	Vehicle category name	Propulsion class	Euro Level ([4])	Mass of carbon monoxide (CO)	Mass of total hydro-carbons (THC)	Mass of Non-methane hydrocarbons (NMHC)	Mass of oxides of nitrogen (NO_x)	Mass of particulate matter (PM)	Test cycle
				L_1 (mg/km)	L_{24} (mg/km)	L_{28} (mg/km)	L_3 (mg/km)	L_4 (mg/km)	
L1e-A	Powered cycle	PI/CI/Hybrid	Euro 5	500	100	68	60	4,5 ([8])	Revised WMTC ([10])
L1e-B-L7e	All other L-category vehicles	PI/ PI Hybrid	Euro 5	1 000	100	68	60	4,5 ([8])	Revised WMTC
		CI/CI Hybrid		500	100	68	90	4,5	Revised WMTC

10. Do you think it is technically feasible to comply with the proposed Euro 5 limit for Total Hydrocarbons and Nitrogen Oxides from L-category vehicles?

- Yes
- No
- Don't know

If YES, please explain how Total Hydrocarbons and Nitrogen Oxides can be reduced in a cost beneficial way using which technology.

If NO, whey are the limits not possible?

15

11. Do you think the alternatives below are valid to assess the non-methane hydrocarbons (NMHC) emissions instead of direct measurement? (select the most appropriate)

- ○ No, direct measurement is the only reliable method
- ○ Estimates based on engine parameters
- ○ Literature data
- ○ Other (Please specify).

16

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type I -Tailpipe emissions tests after cold start

12. Do you think it is technically feasible to comply with the proposed Euro 5 limit for Carbon Monoxide from L-category vehicles?

○ Yes ○ No ○ Don't know

Please explain.

13. Do you think it is technically feasible to comply with the proposed Euro 5 limit for Particulate Matter* from L-category vehicles?

○ Yes ○ No ○ Don't know

Please explain how Particulate Matter can be reduced in a cost beneficial way using which technology.

*** Particulate Matter means components of exhaust gas which are removed from diluted exhaust gas by filters as described in the test procedure (Please see Regulation (EU) No 134/2014 Par 4.5.3.12).**

14. Do you think it is technically feasible to comply with the proposed Euro 5 limit for Particulate Number** from L-category vehicles?

○ Yes ○ No ○ Don't know

Please explain how Particulate Number can be reduced in a cost beneficial way using which technology.

**** The Euro 5/6 legislation for passenger cars introduced a particle number (PN) emission limit in addition to the mass-based limit (particulate mass) in order to ensure that emissions of ultra fine particulate matter (PM 0,1 µm and below) are controlled. Particle number refers to the number of non-volatile particles measured according to the test procedure in UNECE Regulation 83.**

15. Do you think a Particle Number limit would be beneficial in addition to the Particulate Matter limit?

○ Yes ○ No ○ Don't know

Please explain.

16. Do you think it would be meaningful to apply the same method used to measure Particle Number in Passenger Cars to L-category vehicles?

	Yes	No	Don't Know
L1e-A Powered cycle	○	○	○
L1e-B Two-wheel moped	○	○	○
L2e Three-wheel moped	○	○	○
L3e Two-wheel motorcycle	○	○	○
L4e Two-wheel motorcycle with side-car	○	○	○
L5e-A Tricycle	○	○	○
L5e-B Commercial tricycle	○	○	○
L6e-A Light on-road quad	○	○	○
L7e-A Heavy on-road quad	○	○	○
L7e-B Heavy all terrain quad	○	○	○
L7e-C Heavy quadri-mobile	○	○	○

Other (please specify)

17. Do you see additional technical challenges compared to Euro 4 for diesel L-category vehicles to comply with the proposed Euro 5 emission limits?

○ Yes ○ No ○ Don't Know

Please Explain.

18

18. Please indicate the possible additional costs per vehicle that may result from the modification to Type I test cycle (e.g. emission limits, WMTC, adoption of new test cycle).

	< 50€	51 -100€	101-200€	201-300€	301-400€	401-500€	500-700€	700-900€	900-1000€	>1000 €
L1e: Light two-wheeled vehicle (powered cycle or two-wheeled moped)	○	○	○	○	○	○	○	○	○	○
L2e: Three-wheeled moped	○	○	○	○	○	○	○	○	○	○
L5e-B: Commercial trycle	○	○	○	○	○	○	○	○	○	○
L6e-B: Light Quadrimobile	○	○	○	○	○	○	○	○	○	○
L7e-B: Heavy all terrain quads	○	○	○	○	○	○	○	○	○	○
L7e-C: Heavy quadri mobile	○	○	○	○	○	○	○	○	○	○

Please justify answer.

19. In some countries the reference test fuel contains a specified amount of ethanol (5% in EU).

What effects of ethanol in the fuel are, in your opinion, important? (More than one can be selected)

- ☐ Canister deterioration due to ageing
- ☐ Increase in tank permeation
- ☐ Effect on Type I test
- ☐ Effect on Test V durability test
- ☐ Effect on Test IV evaporative test

Please explain.

19

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type III - Emission of crankcase gases

Crankcase emissions consist of hydrocarbons from unburned fuel and lubrication oil coming from the engine. Unburned vapours are usually led back into the intake system of the engine and are subsequently combusted. However, these emissions can be released into the ambient atmosphere if the crankcase ventilation system is not adequately sealed.

Annex V of Regulation 168/2013 sets out the requirement to limit such emissions:

"*Zero emission, closed crankcase. Crankcase emissions shall not be discharged directly into the ambient atmosphere from any vehicle throughout its useful life*."

The description of the Test type III requirements are given inRegulation 134/2014, Annex IV.

20. Do you think that unburnt emissions from the crankcase of L-category vehicles pose a threat to human health and environment if they are released to the ambient atmosphere?

○ Yes ○ No ○ Don't know

Please explain your answer.

21. Do you think that inefficiently operating crankcase systems (based on over pressure and not on vacuum) are expected to have a detrimental effect on engine life (combination of lubrication oil with unburned fuel, water vapour, and particles)?

○ Yes ○ No ○ Don't know

Please explain your answer.

22. Do you think that the crankcase emissions of L-category vehicles are substantial compared to tailpipe emissions?

○ Yes ○ No ○ Don't know

Please explain your answer.

23. What method of verification of the crankcase ventilation system (out of the two additional type III test methods proposed in Annex IV of Reg.134/2014) do you consider more technically demanding?

- ◯ No. 1: Vacuum based
- ◯ No. 2: Over pressure
- ◯ Don't know

Please explain your answer.

24. What method of verification of the crankcase ventilation system do you consider more cost-beneficial?

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type IV Evaporative Emissions

With regard to evaporative emissions, the vehicle manufacturer needs to prove to the technical service, and to the satisfaction of the approval authority, that the fuel tank and fuelling system are leak-tight.

All L-vehicle (sub-)categories equipped with a non-metallic fuel storage should be tested according to the permeability test procedure laid down in Appendix 1, Annex V of Regulation EU 134/2014.

Fuel permeation test set out in Appendix 2 or the SHED test outlined in Appendix 3 may replace the evaporative part of the permeability test set out in Appendix 1 of the Euro 5 step.

Each subcategory will only be subject to a single test procedure. Annex VI(C2) of Regulation 168/2013 contains limits for permeation and SHED tests in anticipation of the decision which test procedure shall be applied (i.e. the permeation or SHED test).

25. Which test procedure (permeation test procedure or SHED) is more cost beneficial for the following (sub-) categories of vehicles?

	Permeation test	SHED	Don't Know
L1e	☐	☐	☐
L2e	☐	☐	☐
L5e-B	☐	☐	☐
L6e-B	☐	☐	☐
L7e-B	☐	☐	☐
L7e-C	☐	☐	☐

Please justify your answer.

26. Is it justified to lower the SHED test limit from 2000 mg/test to 1500 mg/test for the following (sub-)categories that are already subject to SHED testing (as of Euro 4 2016) to better balance the fuel storage tank*, fuel delivery system dimensions and the limit?

	Yes	No	Don't Know
L3e	☐	☐	☐
L4e	☐	☐	☐
L5e-A	☐	☐	☐
L7e-A	☐	☐	☐

Please justify your answer.

* Passenger cars with a fuel tank size of 4 to 5 times bigger than the ones of L-category vehicles are also tested with the SHED test and are subject to the 2000 mg/test limit. NB: the fuel tank size is the critical parameter of evaporative emissions.

27. Do you expect that a Euro 5 SHED test compliant vehicle will need to be equipped with additional/modified hardware (e.g. carbon canister dimensional change)?

○ Yes ○ No ○ Don't Know

Please explain.

24

Type V Durability of Pollution Control Devices

Article 23, Paragraph 3 of Regulation 168/2013 describes three possible methods that manufacturers can choose to ensure that type-approval durability requirements are met:

(a) actual durability testing with full mileage accumulation;

(b) actual durability testing with partial mileage accumulation;

(c) mathematical durability procedure.

There are two durability distance accumulation test cycle alternatives available:

Method (a) AMA

Method (b) SRC-LeCV cycles.

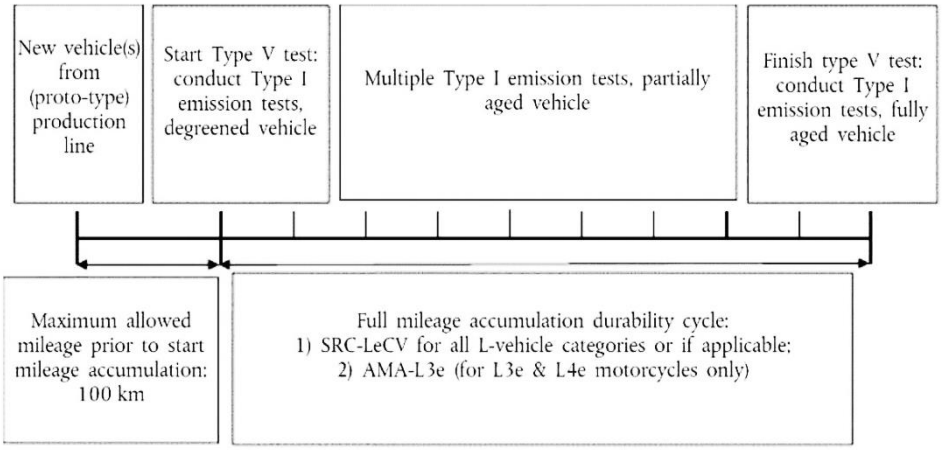
The EU considers the AMA test cycle to be obsolete. Its application has been tolerated only for the sake of worldwide harmonization.

The other durability cycle, SRC-LeCV, focuses on operating modes and real-world after-treatment ageing. This cycle can on average be conducted twice as fast in comparison to the AMA cycle, resulting in significant lower costs and provides more flexibility for manufacturers.

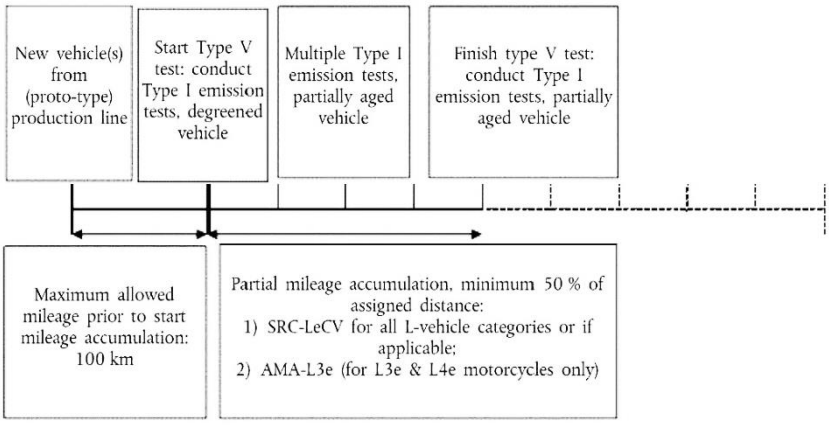
However, the SRC-LeV replicates the global average driving conditions (WMTC engine speed and load points) and is more challenging in comparison to the AMA cycle, which was developed for passenger cars in the 1970s in the era before vehicles were equipped with pollution control devices.

The SRC-LeV is in fact a set of four different cycles applicable to different L-vehicle categories depending on the same classification criteria as for Test type I (power and max design vehicle speed).

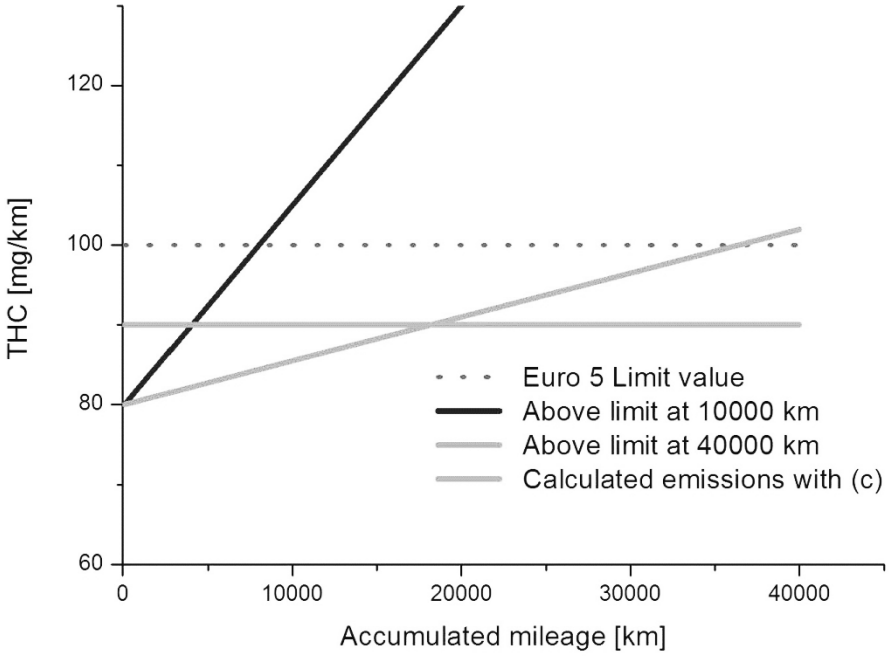
Test type V – durability test procedure with full mileage accumulation



Test type V – accelerated durability test procedure with partial mileage accumulation



Example: The figure below presents the Euro 5 THC limit value, emissions calculated with the deterioration factor, mathematical method (c), and two possible cases where emissions are actually above the limit after 10,000 km and 40,000 km accumulated distance.



28. Do you think that the mathematical method is effective compared to the methods (a) and (b)?

Yes No Don't Know

Please explain.

29. Do you think that the deterioration factors laid down in Annex VII(B) of Regulation (EU) No 168/2013 are appropriate and should be maintained or revisited beyond the Euro 5 step?

Appropriate and should be maintained Should be revisited beyond the Euro 5 Step Don't Know

Please explain.

27

30. Taking the pros and cons into account (i.e. international harmonisation vs. highly questionable effectiveness) is it justified to phase-out the AMA distance accumulation test cycle as an alternative beyond the Euro 5 step (after 2020)?

- Yes
- No
- Don't Know

If YES, by when?

31. In the negotiations before adopting Regulation (EU) No 168/2013, the initial proposal of a 50,000 km distance accumulation (10 years life of a motorcycle X 5000 km average distance accumulation) for the Euro 5 step was lowered for an L3e-A3 motorcycle (>35 kW) and set equal to the Euro 4 distance (35,000 km), initially proposed for an L3e-A2 motorcycle (medium power between 11 and 35 kW power).

Do you agree that the distance should be increased for an L3e-A3 motorcycle to a representative 50,000 km for such a motorcycle type beyond the Euro 5 step (after 2020)?

- Yes
- No
- Don't Know

Please explain.

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type VII Energy Efficiency Test

Energy efficiency test means testing of the fuel/energy consumption, carbon dioxide emissions and electric range for L-category vehicles equipped with a conventional combustion engine (CO2 emissions, fuel consumption), a hybrid electric powertrain (energy consumption and electric range) or for a pure electric vehicle (energy consumption and electric range).

Article 24 (1) of Regulation 168/2013 states that carbon dioxide emissions shall be determined in the applicable laboratory emission test cycle by the manufacturer and reported by the manufacturer to the approval authority and to the consumer at point of sale.

The intention of test type VII is to measure the energy efficiency in an harmonised and objective way and to make this information available to the consumer at point of sale. Please note that at the moment there are no limit values, and the European Union is not considering to introduce them in the Euro 5 step.

32. In your opinion, what are the technologies with the highest potential for improving the fuel efficiency of L-category vehicles?

33. Please list the different costs likely to be incurred per vehicle as a result of the Type VII test cycle?

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Type VIII Functional OBD & Test Type VIII Environmental Tests OBD Verification

The main objective of on-board diagnostics (OBD) is to ensure effective and efficient vehicle repair. In addition, many of the OBD features have beneficial secondary effects on environmental protection and vehicle functional safety.

An objective of the Euro 5 regulation is to ensure the full and non-discriminatory access to vehicle on-board data and the diagnostic information. This is to be used as a key input in vehicle repair and maintenance and to level the playing field among authorised and independent repairers. It is intended to increase competition and lower repair and maintenance of L-category vehicles.

34. What do you consider are the advantages of enhanced on-board diagnostic requirements compared to the basic requirements introduced in the Euro 4 step for L-category vehicles?

- [ ] Better diagnostic quality information to the repairer - making repairs more effective and efficient
- [ ] Reduction of repair costs to user owing to more effective and efficient repair of complex powertrain technology and increased competition between authorised and independent repairer
- [ ] Enhanced functional safety requirements (e.g. fast warning/notification enhanced default modes protecting rider and vehicle)
- [ ] Improved component/safety/production quality without increase of cost to end consumer owing to increased competition between vehicle manufacturers
- [ ] Increased innovation in vehicle environmental and functional safety performance features
- [ ] Increased export of technology and intellectual property to non-EU, global markets which follow EU legislation

Other (please specify)

35. What do you consider are the disadvantages of enhanced on-board diagnostic requirements compared to the basic requirement introduced in the Euro 4 step for L-category vehicles?

- [ ] Longer vehicle development, production and system complexity
- [ ] Increase vehicle cost passed on to the consumer
- [ ] Additional warranty cost
- [ ] Risk of loss of reputation of the vehicle manufacturer/repairer owing to quality problems that could be emerging as a result of an enhanced on-board diagnostic system
- [ ] Increase research and development investments to deal with legal requirements
- [ ] Not technically feasible - new technologies need to be developed
- [ ] Perception by consumers based on experience with car legislation: on-board diagnostic is only an environmental protection feature and not willing to pay for this additional functionality
- [ ] Other (please specify)

36. In your opinion, what are the environmental benefits of the key elements of OBD stage II?

- ( ) More advanced electric circuit diagnostics
- ( ) Catalyst diagnostics
- ( ) Oxygen response
- ( ) Ratio monitoring
- ( ) Other kind of savings (e.g. repair, costs)
- ( ) Please explain your answer (e.g. tons of saved emissions)

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Off-Cycle Emissions and Energy Efficiency Determination

The Euro 5 environmental effects study should, *inter alia*, assess the feasibility and cost-effectiveness of in-service conformity testing requirements, off-cycle emission requirements and a Particulate Number emission limit for certain (sub-) categories.

On the basis of the environmental effects study, the Commission should consider a proposal to introduce new elements into future type-approval legislation applicable after the Euro 5 environmental step.

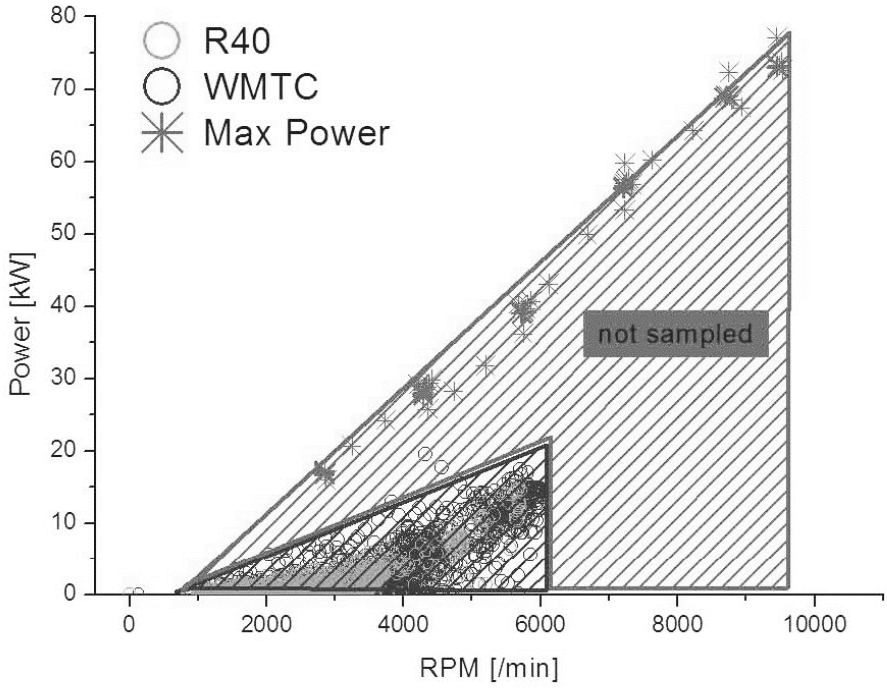
Concerning "off-cycle emission requirements", it is envisaged that an engine should be clean and energy efficient both when tested in legislative driving cycles and under real-world conditions not captured in the legislative test cycle.

Test cycles are crucial to comparing the environmental performance of vehicles, but owing to certain assumptions, e.g. flat terrain and test cell temperature between 20° and 30°C (whereas the average ambient temperature in EU is 8°C) the results might not be representative of real-world environmental performance.

Example

The figure below was obtained from a manual transmission motorcycle (L3e-A3) on a chassis dynamometer. It shows power versus engine speed within the WMTC, the R40 driving cycle (UNECE- Regulation No. 40) and at Wide Open Throttle performance to show the ultimate boundary of feasible engine operation.

The red hatched part-load area consists of feasible part-load points which maybe covered by the engine under real-word driving conditions but are not sampled during the R40 or WMTC tailpipe emission tests.



37. Do you think future off-cycle emission requirements are needed to prevent the optimisation of the environmental performance of the vehicle to pass **only** the test type approval cycle?

- Yes
- No
- Don't Know
- Please Explain

38. Do you think a particular procedure should be followed to obtain reliable off-cycle emission and energy efficiency data for L-category vehicles, and made obligatory in approval legislation beyond 2020?

- Yes
- No
- Don't Know

Please Explain

39. Do you think that chassis dynamometer tests are the correct approach to obtain off-cycle information for L-category vehicles?

- Yes
- No
- Don't Know

Please Explain

40. In your opinion, are there any further technical issues (technical feasibility) that should be investigated with regard to the application of Euro 5 requirements to L-category vehicles?

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Thank You!

41. Please use the box below to provide any further information that would be helpful to our survey.

Thank you for taking part in our survey.

Please pass the survey link on to other relevant organisations.

Stakeholder Survey on Euro 5 Environmental Step for L-Category Vehicles

Thank You!

41. Please use the box below to provide any further information that would be helpful to our survey.

Thank you for taking part in our survey.

Please pass the survey link on to other relevant organisations.

LD-NA-27588-EN-N

JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

Publications Office

doi: 10.2790/974882

ISBN 978-92-79-53929-9