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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND
THE COUNCIL**

on the effects of the Euro 5 Environmental Step for L-category vehicles

1. INTRODUCTION

Regulation (EU) No 168/2013¹ sets out Euro 4 and Euro 5 emission limits and the associated technical requirements and test procedures with respect to the Euro 5 step, to provide vehicle manufacturers and the supplier industry with long-term planning predictability². Together with its four delegated and implementing acts³ it forms a comprehensive package of measures for the safety, emissions control and placing on the market of such vehicles.

Annex IV to the Regulation sets the timetable for the introduction of the different tests and other technical requirements in respect of type-approval. Thus the Euro 4 emission limits were introduced for new vehicles of certain subcategories on 1 January 2016 but it was only on 1 January 2017 that these limits became mandatory for all new types of vehicles.

Regarding the Euro 5 emission limits, the Regulation provides that they shall become mandatory for all new types of vehicles of all sub-categories as of 1 January 2020.

In order to underpin this two-step approach, Article 23(4) of the Regulation requires the Commission to conduct an environmental effect study through modelling, technical feasibility and cost-effectiveness analysis based on the latest available data.

The objective of this study, as pointed out by the above-mentioned Article, is to evaluate and confirm the feasibility and cost-effectiveness of the Euro 5 emission limits. By gathering and analysing the latest available data and research findings, the study should substantiate the adoption of further policy measures which would amend and complement the existing framework. Hence, Article 23(4) clearly defines the scope of the environmental effect study.

¹ Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles (OJ L 60, 2.3.2013, p. 52).

² The provisions on the Euro 4 step were based on, and justified in detail by, a Commission impact assessment ([SEC\(2010\) 1152](#)).

³ Commission Delegated Regulation (EU) No 134/2014 of 16 December 2013 supplementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to environmental and propulsion unit performance requirements and amending Annex V thereof (OJ L 53, 21.2.2014, p. 1).

Commission Delegated Regulation (EU) No 44/2014 of 21 November 2013 supplementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to the vehicle construction and general requirements for the approval of two- or three-wheel vehicles and quadricycles (OJ L 25, 28.1.2014, p. 1).

Commission Delegated Regulation (EU) No 3/2014 of 24 October 2013 supplementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to vehicle functional safety requirements for the approval of two- or three-wheel vehicles and quadricycles (OJ L 7, 10.1.2014, p. 1–12)

Commission Implementing Regulation (EU) No 901/2014 of 18 July 2014 implementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to the administrative requirements for the approval and market surveillance of two- or three-wheel vehicles and quadricycles Text with EEA relevance (OJ L 249, 22.8.2014, p. 1–202)

The environmental effect study was commissioned to an external consultant – a consortium led by TNO⁴ after a call for tenders. The final report of the study was submitted on 18 May 2017 and approved by the Commission on 20 July 2017.

Based on the findings of this study and pursuant to its obligation under Article 23(5), the Commission is presenting the following report to the European Parliament. It covers the following aspects:

- An analysis of the feasibility and cost-effectiveness of the enforcement dates of the Euro 5 level;
- An analysis of the adequacy of the Euro 5 emission limits referred to in Annex VI and OBD threshold in Annex VI of the Regulation in light of the most recent available data;
- A cost-benefit analysis of the foreseen introduction of OBD stage II at the Euro 5 level for (sub) categories L3e, L5e, L6e-A and L7e-A and;
- A review of the durability mileage for the Euro 5 level referred to in Annex VII (A) and the deterioration factors for the Euro 5 limit referred to in Annex VII (B) of this Regulation.

Annex V of Regulation (EU) No 168/2013 enumerates the eight test-types to which L-category vehicles are subjected during type-approval. In the framework of the study, five of those tests (types I, II, III, IV and VII) were carried out on a large number of L-category vehicles in different environments to collect basic information on the emissions-related performance of the vehicles and their individual components. The results were used to examine the potential effectiveness of different policy options, provide input for the modelling approaches adopted in the study and validate the main conclusions reached.

The information thus obtained also formed the basis of a dedicated cost-benefit analysis model to assess the societal costs of policy options within the Euro 5 step and beyond, i.e. to help determine whether particular options result in a net benefit or loss to society, in monetary terms. In the context of the study, an option generates a net benefit where environmental savings, converted into monetary terms, exceed investment and implementation costs.

Overall, the study concluded on a positive cost/benefit assessment of the Euro 5 provisions in EU legislation and indicated good technical feasibility of the Euro 5 step. The detailed conclusions of the study have been published in the report "Effect study of the environmental step Euro 5 for L-category vehicles"⁵.

On the basis of its findings, the study also outlined possible areas of improvement beyond the Euro 5 step, concerning in particular in-service conformity testing, off-cycle emission (OCE) requirements and particle number emissions limits for certain categories. However a further in-depth study on the feasibility and cost-effectiveness of such measures should be carried out before considering translating them into policy instruments.

⁴ www.tno.nl

⁵ <https://publications.europa.eu/en/publication-detail/-/publication/f3f268fc-943f-11e7-b92d-01aa75ed71a1/language-en/format-PDF/source-37961262>

2. ASSESSMENT OF THE ENVIRONMENTAL EFFECTS OF EURO 5

Emissions information was collected using seven test types that are part of the type-approval procedure for new L-category vehicles. This section summarises the main findings and highlights areas in which EU legislation could be improved in the light of these findings.

2.1. Assessment of the Euro 5 emission limits⁶ and test procedures

For the purpose of type-approval the manufacturer needs to show that the vehicles, systems or component meet the requirements and test procedure laid down in the Regulations (EU) No 168/2013 and its four delegated and implementing acts. Several test types have to be performed, each concerning a specific requirement (e.g. test type VII deals with CO₂ emissions). During the environmental effect study for the Euro 5 step, the hereafter mentioned test types were evaluated.

2. 1. 1 Assessment of Type I test- Tailpipe-Emissions after cold start and overall Euro 5 limits

Test type I was used to assess the suitability of the World harmonised Motorcycle Test Cycle (WMTC) for all L-category vehicles, and of the Euro 5 limits as required under Article 23 of Regulation (EU) No 168/2013. The WMTC is a system of driving cycles used to measure fuel consumption and emissions in motorcycles. It has been developed under the United Nations World Forum for Harmonization of Vehicle Regulations and has been introduced in Regulation (EU) No 168/2013 for the application to the larger motorcycles in a first step, with the objective of expanding the use of the WMTC to other L-category vehicles. The extension of the WMTC to other L-category vehicles is based on the view that the use of vehicles in congested urban areas is better reflected in the WMTC than in existing driving cycles therefore one of the objectives of the study was to provide confirmation that this drive cycle can indeed be extended to all L-cat vehicles.

The results of the study determined that the WMTC is suitable for use for all L-category vehicles. It provides better environmental protection in the course of real-world operations than the driving cycles currently used.

Concerning the Euro 5 limits in Regulation (EU) No 168/2013, the study finds that overall both limits and associated dates for implementation are cost-beneficial and technically feasible for all L-category vehicles. It appears that compliance with emissions limits will depend on incremental technical improvements rather than engineering breakthroughs. Despite cost increases due to new technology, major environmental benefits stemming from the Euro 5 step will lead to a significant overall net monetary benefit, which may collectively exceed EUR 330 million between 2020 and 2040.

In addition, Euro 5 mopeds and motorcycles would be among the cleanest conventional road vehicles in urban conditions.

The study however also points out that due to their specific characteristics and usage there is a need for an extended lead time for the three following sub-categories: mini cars (L6e-B), three wheel mopeds for utility purposes (L2e-U) and the enduro and trail motorcycles (L3e-AxE; L3e-AxT).

⁶ Annex VI (A2) to Regulation (EU) No 168/2013.

For mini cars and three wheel mopeds for utility purposes, the impact assessment of 4 October 2010 carried out by the Commission prior to the adoption of Regulation (EU) No 168/2013 already outlined their limited market share in proportion to the total L-category fleet as well as their low average annual mileage⁷. The study report provided data for 2015 confirming that the market share of mini cars (27 000 vehicles) in comparison to the total L-category market (1.2 million vehicles) is small, only 2.25%⁸. In the light of this assessment, the Commission has concluded that there has been no significant evolution of the market share of the mini cars which would change the conclusions of the impact assessment conducted in 2010.

Furthermore, as the original Impact assessment of 2010 had already pointed out, the manufacturers of mini cars are SMEs which are often established in regions lacking a developed industrial network and which have limited resources for R&D.

Mini cars are mostly equipped with very small, diesel powered compression ignition engines. Therefore, it is not certain that these engines can be sufficiently adapted to meet the Euro 5 emission limits and even if such adaptation was to be proven feasible, the cost would exceed the environmental benefits leading to EUR 65 million total damages in monetary terms.

In order to avoid such negative impact, the study recommended providing for a transition period of four years which would allow the manufacturers of mini cars to channel their R&D efforts and investments into the development of alternative technologies covering the Euro 5 limits.

After further evaluation of the extension recommended by the study, and taking into account on the one hand the Commission's environmental objectives and promotion of clean transport and on the other hand technical feasibility and competitiveness of the industry, in particular SMEs active in the sector of mini cars, the Commission concluded that two years extra lead time would be sufficient for the industry to shoulder obligations stemming from new regulatory limits.

The extra lead time of two years for such vehicles, i.e. to 2022 for new vehicles and 2023 for all vehicles, would still allow the manufacturers of the concerned vehicles to develop new (e.g. electric or petrol-hybrid) powertrains and take advantage of the expected drop in the cost of manufacturing batteries due to increased global production. It would also allow cities to provide additional charging infrastructure. The cost-benefit analysis estimated that the potential net benefits, taking into account the delay in the introduction of the Euro 5 step for the above-mentioned categories, would be in the order of EUR 230 million.

In the light of the above recommendations by the study, the Commission has come to the conclusion that pushing back the introduction date of the Euro 5 step for the mini cars by two years would be more cost-beneficial than enforcing it in 2020 (Base line). The negative environmental impact caused by the extra lead time granted to the mini cars would be counterbalanced after the Euro 5 step becomes mandatory in 2022 as in the meantime the manufacturers would have been able to develop cleaner vehicles.

⁷ COM(2010) 542 final, page 73

⁸ Effect study of the environmental step Euro 5 for L-category vehicles", section 2.5.2.2, p.54

Furthermore, the Commission has concluded that the introduction of the Euro 5 step at the foreseen date in 2020 could imply that mini cars may simply disappear from the market. This would entail negative economic and social consequences as these vehicles provide for the social needs of a group of people not being able to obtain a regular driver licence, e.g. elderly and disabled people as well as younger people as an alternative for the mopeds.

Regarding enduro and trial motorcycles, the study report points out that these vehicles are not used for regular commuting but mostly for leisure activities in both road and off-road conditions. They are also used, on average, for only a few hours per year (equivalent of 10-15 days) and have short lifetimes (4-5 years)⁹. Hence the study recommends excluding these vehicles from the requirements of OBD II stage.

According to data provided by the industry, the market share for enduro and trial motorcycles in 2015 represents around 2.25% of the total L-category fleet which is comparable to the share of mini cars and utility tricycles.

Considering both the low mileage during the useful life of enduro and trial motorcycles as well as their limited market share, their contribution to the total pollutant emissions is to be seen as marginal. Furthermore, these vehicles have manufacturing processes which are similar to those of mini cars. Therefore, since the study recommended providing for an extended lead time for the mini cars, the Commission is considering also providing a similar extension for the enduro and trial motorcycles. Such a solution would allow for a consistent set of rules to be applied to sub-categories which present similar characteristics.

In view of the above and in line with the conclusion regarding mini cars, the marginal negative environmental impact caused by the extra lead time granted to the enduro and trial motorcycles would be entirely counterbalanced after the Euro 5 step becomes mandatory in 2022 as in the meantime the manufacturers would have been able to develop cleaner vehicles.

As a subtask, the study assessed whether it was appropriate to measure separately the limits for non-methane hydrocarbons (NMHCs) and total hydrocarbons (THCs), as currently required under Regulation (EU) No 168/2013. It concludes that separate measuring should be maintained, as it enables separate reporting on air pollutants and greenhouse gas emissions.

2. 1. 2 Assessment of Type II test- Tailpipe emissions at (increased) idle and free acceleration

Regulation (EU) No 134/2014 in its Annex III introduced a revised procedure to check tailpipe emissions at (increased) idle and free acceleration, in order to align type-approval requirements with other vehicle types and be coherent with the requirements set out in the latest legislation on roadworthiness testing. The appropriateness and smooth implementation of the procedure had to be confirmed in this study.

The test in general is easy to perform. However, the description for setting the different engine rotation speeds during the test, as described in the procedure in Annex III of Regulation (EU) No 134/2014 could lead to a misinterpretation by test engineers. The study makes specific technical recommendations for improving the description of the test.

2. 1. 3 Assessment of Type III test- Emissions of crankcase gases

⁹ Effect study of the environmental step Euro 5 for L-category vehicles", section 9.9, page 238

Test type III (on crankcase gases) of Annex IV of Regulation (EU) No134/2014 verifies that engines are constructed so as to prevent fuel, lubrication oil or crankcase gases from escaping directly into the atmosphere without being combusted. The study points out that some minor adjustments could be made to improve the test procedure currently set out in the Regulation, e.g. adapting the sample bag used in the procedure to the engine capacity. The study recommends also to change the order of the currently set out test procedures. This will lead to an improvement in the quality of the evolution of the test performed. The proposed changes will not have any effect on the overall cost-benefit.

2. 1. 4 Assessment of Type IV test - Evaporative emissions test

The legislation for the Euro 4 step introduced provisions on evaporative emissions and set out corresponding test procedures for certain L-category vehicles. Subsequently, in the Euro 5 step these requirements are extended to all L-category vehicles. The study evaluated which of the two available evaporative emissions test procedures set out in Annex V of Regulation (EU) No 134/2014 (permeation or sealed housing evaporative determination (SHED)) is more appropriate and cost-beneficial for the vehicle types that were not already covered in the Euro 4 step. It concludes that for certain L-category vehicles¹⁰, the permeation test is the better option, as it leads to environmental benefits that in this case by far exceed technology costs (net monetary benefit for all vehicles will be in the order of EUR 61 million).

2. 1. 5 Assessment of Type VII test -Energy efficiency test (CO₂ emissions fuel /energy consumption and electric range)

The study reviewed whether the test type VII is appropriate for determining CO₂ emissions, fuel consumption, and the electric range for hybrid or fully electric vehicles. The results indicate that the procedures are adequate. It is recommended to carry out a future study on hybrid electric L-category vehicles' CO₂ emissions and fuel consumption as soon as these vehicles penetrate the market and more real data becomes available.

2.2. Assessment of OBD stage II and durability at Euro 5 level

The study assessed the application of OBD stage II at Euro 5 level for certain sub-categories of L-category vehicles (L3e, L5e, L6e-A, L7e-A.).

The aim of introducing OBD requirements for L-category vehicles was not only to monitor the environmental performance and provide the appropriate signals in case of malfunctioning of the emission system to the vehicle owner via activation of an indicator lamp on the dashboard, but also to support the successful repair of a vehicle by providing authorised and independent repairers with access to essential vehicle information. The OBD stage I requirements involve monitoring electric circuits and electronic failure of the emission control system. The update of the requirements with the introduction of OBD stage II as of 2020, as foreseen in Article 21 of Regulation (EU) No 168/2013, would allow the detection of serious degradation in powertrain and environmental systems and its components.

The assessment covered several aspects of the OBD stage II environmental tests, assessed their technical feasibility and cost-benefit and proposed changes in the monitoring procedure.

¹⁰ L1e, L2e, L5e-B, L6e-B, L7e-B and L7e-C.

The Commission agrees with the findings of the study that identifies catalyst monitoring and misfire detection as the two critical components enabling implementation of OBD stage II. Catalyst monitoring involves monitoring the operation of the catalyst over the lifetime of the vehicle. Misfire detection is important in detecting engine ignition malfunctioning. Misfire can lead to higher emissions from the engine, which will shorten the life of the catalyst, resulting in higher repair and maintenance costs and an increase in pollution from the vehicle.

The study points to the technical limitations of catalyst monitoring for certain vehicles and indicates that the technical development required for its implementation is not expected to be ready for the first round of Euro 5 implementation, but should be foreseen for 2024.

For misfire detection, the technology is already available and can be derived from passenger car applications. However, it needs to be adjusted to allow efficient monitoring functionality for L-category vehicles while at the same time eliminating false misfire detection. The study recommends narrowing the window (bandwidth) for misfire detection and making it more robust in order to eliminate as far as possible the impact of external factors, e.g. vibrations from the road surface, which could lead to false positives. Taking the recommendations into account misfire detection could therefore be implemented as envisaged by 2020.

As regards successful vehicle repair, the study confirms that OBD stage II would allow catalyst malfunction to be detected even outside periodic environmental technical inspections. For misfire detection, trouble codes can provide useful information on the source of a potential technical malfunction, but the study warns that reliable misfire diagnosis is required to avoid costly troubleshooting by the repair and maintenance workshops. By following the recommendation made in the study and adjusting the window in which misfire should be detected the risk of reporting a false and thus unnecessary trouble could be mitigated.

The study also assessed in-use performance ratios (IUPR). The aim of IUPR is to set minimum monitoring requirements in order to ensure that the OBD system is functioning correctly. For example an IUPR of 0,1 (10%) means that during at least 10 % of the total duration of every measurable real driving trip ,the important emission control components or systems must be monitored. The study finds that IUPR should be implemented gradually allowing for an introductory period until 2024 to enable type-approval authorities and manufacturers to become familiar with the IUPR functionality. The requirement should be implemented for new vehicles in 2020 and for all vehicles in 2021 using the current Euro 4, OBD stage I emission thresholds (OTL I)¹¹, combined with an IUPR ratio defined by the manufacturer.

The OTL defines the emissions threshold limit which needs to be achieved before a malfunction is reported. As of 2024 for new vehicles and 2025 for all vehicles, the minimum IUPR ratio as currently foreseen in the Euro 5 step (10%), together with the Euro 5 emission threshold (OTL II)¹² should be mandatory. Consideration could be given to applying more stringent IUPR limits in the future, but a specific cost-benefit study should be carried out beforehand.

Focusing on certain sub-categories of L-category vehicles, such as enduro and trial motorcycles, which are very particular and have a short lifetime, the study finds that OBD

¹¹ [Euro 4, OBD stage I OBD emission thresholds \(Annex VI \(B1\) to Regulation \(EU\) No 168/2013\).](#)

¹² Euro 5, OBD stage II OBD emission thresholds (Annex VI (B2) to Regulation (EU) No 168/2013).

effectiveness is questionable. Therefore, the study recommends extending existing partial exemption from OBD II for heavy all terrain quadricycles to enduro and trial motorcycles, which are very similar to them in nature and use. Furthermore, considering that the manufacturers of such vehicles are mainly SMEs with limited means for R&D expenditure, the costs that they would have to bear to comply with OBD II provisions would not be compensated by the environmental benefits as these vehicles have a marginal environmental impact as mentioned in paragraph 2.1.1.

2.3. Durability mileages¹³ and deterioration factors¹⁴ for Euro 5

The Commission asked for a comparison between the two cycles used for durability testing under the current regulation, namely the Approved Mileage Accumulation (AMA) test cycle and the Standard Road Cycle for L-category vehicles (SRC-LeCV). The purpose was to determine which of the two durability cycles is most suitable for L-category vehicles and better reflects the deterioration under real driving conditions. The conclusion of the study is that the SRC- LeCV is most suitable overall for all L-category vehicles and more in line with the world harmonised transient cycle (WMTC) which is used in the type I emission test. The SRC-LeCV reflects better the deterioration of the emission performance over the life time of the vehicle compared to real driving.

However, the study also concluded that a complete phasing out of the AMA cycle after 2020 is not necessary, as this is still useful for vehicles with a moderate and low speed profile, for which it provides the same accuracy as the SRC-LeCV and has already been globally accepted and used for many years. This is why the Commission concludes that keeping the AMA test cycle for these specific vehicles would contribute to maintain the testing costs and administrative burden as low as possible by avoiding the need to conduct double testing.

The Commission acknowledges the conclusions of the study to phase out the AMA test cycle only for larger motorcycles and the necessity to introduce minor changes to the SRC-LeCV sub-classification of vehicles to better define to which subclass a vehicle with specific characteristics (engine size and speed) belongs; this would make the SRC-LeCV more robust.

The study finds that the mathematical procedure in point (c) in Article 23(3) of Regulation (EU) No 168/2013, whereby vehicles are only tested after 100 km of use, does not reflect the real degradation of the emissions control system of a vehicle during its lifetime. It recommends phasing out this method in 2024 and suggests bench ageing¹⁵ as a more reliable and less costly method than full mileage accumulation. The bench ageing procedure is already well established and accepted as a robust method for determining the degradation of emissions control systems in other motor vehicles. With some minor adjustments, this procedure could be implemented by 2020.

The study finds that the ‘useful life values’ in Regulation (EU) No 168/2013 are generally appropriate for most vehicle categories, but suggests revising the lifetime for mopeds. It considers the current values for moped lifetime to be too low and suggests conducting a specific data collection survey to gather robust information. It also suggests that it would be appropriate to make a proposal for adaptation to future change.

¹³ Annex VII (A) to Regulation (EU) No 168/2013.

¹⁴ Annex VII (B) to Regulation (EU) No 168/2013.

¹⁵ [The bench ageing procedure is already used for passenger cars; see UNECE Regulation 83.](#)

3. POSSIBLE AREAS FOR IMPROVEMENT BEYOND EURO 5

On the basis of its findings, the study also outlined possible areas for improvements beyond the Euro 5 step. The following subjects are touched upon: Off-cycle emissions requirements; In-service conformity testing requirements and Particulate number emission limit for certain (sub-) categories.

3.1. Off-cycle emission (OCE) requirements

The study assessed the possibility of implementing OCE testing for L-category vehicles. The test results and subsequent analysis led to the following conclusions:

OCE requirements are expected to be an appropriate measure for ensuring low emissions from L-category vehicles in everyday operation and better reflecting real driving conditions. The anticipated benefits are significant and outweigh the additional costs. The portable emissions measuring system (PEMS)¹⁶ appears to be the most suitable method for gauging OCEs. Due to the wide variety of L-category vehicles, specific requirements will have to be developed for different WMTC classes.

The study recommends compiling definitive evidence of the viability OCE requirements in order to prepare for their introduction in EU legislation after 2020.

3.2. In-service conformity testing requirements

The study reviewed the need for in-service conformity testing requirements. It found that a number of vehicles currently on the market have excessively high emissions levels. The conformity factors are in the range of 1.5 to 25 for CO emission and 0.4 to 1.2 for HC and NOx. However, the study notes that the majority of vehicles on the market are approved according to Directive 2002/24/EC¹⁷ under which the anti-tampering requirements are not as stringent as under Regulation (EU) No 168/2013, the discrepancies found exceed even the emission limits set out in Directive 2002/24/EC.

The study concludes that the introduction of in-service conformity testing is technically feasible and may be an effective and cost-beneficial measure to secure proper emissions levels from in-use vehicles during their useful life. However, the study recommends assessing in the first place effectiveness of the measures taken in the Euro 5 step before coming to a final conclusion on the need to introduce in-service conformity testing and developing the technical details of such procedure.

3.3. Particulate number emission limit for certain (sub-) categories

The Euro 5 step introduces the Particulate Matter (hereinafter PM) limits for direct injection (DI), positive ignition (PI) and compression ignition (CI), i.e. diesel vehicles, at a level of 4.5 mg/km, similar to those for passenger cars. The study reviewed these limits and evaluated if particle number limit (PN) for L-category vehicles should be introduced.

¹⁶ The existing PEMS equipment needs further development in order to be adapted for use on a larger scale.

¹⁷ Directive 2002/24/EC of the European Parliament and of the Council of 18 March 2002 relating to the type-approval of two or three-wheel motor vehicles and repealing Council Directive 92/61/EEC (OJ L 124, 9.5.2002, p. 1).

The PM limits introduced by Regulation (EU) 168/2013 for PI, DI and diesel vehicles were found to be cost-beneficial. Concerning the possible introduction of a PN limit for L-category vehicles, the study concludes that a better understanding would be needed of the emissions performance of such vehicles, when new emissions control technologies become available at the Euro 5 step.

4. CONCLUSIONS

Based on its assessment of the study and targeted stakeholders consultations it conducted throughout the study's total duration, the Commission draws the following final conclusions:

1. The assessment generally indicates that the existing Euro 5 emission limits, dates, requirements and test procedures, set out in Regulation (EU) No 168/2013, are both feasible and cost-effective.
2. The introduction date for the Euro 5 step for mini cars (L6e-B), three wheel mopeds for utility purposes (L2e-U) and the enduro and trail motorcycles (L3e-AxE; L3e-AxT): the adjustments to the emission control system needed cannot be introduced by 2020 in a cost-effective way for the engines currently fitted in those vehicles. An extra lead time of two years should allow manufacturers to move away from Euro 4 powertrains and introduce the Euro 5 step in a cost-beneficial way for these vehicle categories.
3. OBD II requirements: there is a need to change the window of misfire detection and to extend the lead time for the introduction of catalyst monitoring to ensure accurate monitoring of the emission control systems.
4. In Use Performance Ratios (IUPR) introduced at the Euro 5 step: IUPR should be implemented gradually, allowing for an introductory period to enable that type-approval authorities and manufacturers become familiar with the IUPR functionality.
5. The mathematical durability procedure for environmental performance requirements as set out in Article 23(3)(c) of Regulation No 168/2013: there is a need to phase out this procedure. The mathematical durability procedure does not reflect properly the actual deterioration of the environmental performance of a vehicle during its lifetime. Under the mathematical approach, new vehicles are only driven for 100 km during which they are tested, which does not reflect the ageing of the emission control device over the lifetime of the vehicle. Therefore, this method does not guarantee the environmental performance during the entire life of a vehicle.
6. The drive cycles used for the durability requirements: a complete phasing out of the AMA cycle after 2020 is not necessary, as this is still useful for vehicles with a moderate and low speed profile, for which it provides the same accuracy as the SRC-LeCV. Phasing out is therefore only recommended for larger motorcycles.

7. Mileage accumulation durability procedure: there is a need to introduce a bench ageing procedure as an alternative to full and half mileage accumulation, as required in Article 23(3)(a) and 23(3)(b) of Regulation No 168/2013.

In accordance with Article 23(5) and 23(6) of Regulation (EU) No 168/2013 and the outcome of the study, the Commission will consider making appropriate proposals for future amendments to the type approval legislation.