

Euro 6e: Changes to the European Union light-duty vehicle type-approval procedure

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On July 5, 2022, European Union Member States adopted an amendment¹ to the type-approval test procedure regulation for light-duty vehicles, (EU) 2017/1151.² It is the second major revision of the current type-approval regulation after amendment (EU) 2018/1832,³ which extended Euro 6d requirements and was adopted late 2018.⁴ Since the amendment introduces a revised set of type approval test procedure requirements but does not change the applicable Euro 6 emission limits as defined in (EC) 715/2007, it is referred to as Euro 6e.

This policy update summarizes the key changes to the European Union type-approval procedure regulation that are introduced by the Euro 6e amendment.

The emission standards regulation (EC) No 715/2007 gives the European Commission the power to implement the type-approval test procedure without the involvement

1 European Commission, "Commission Regulation (EU) .../... of XXX Amending Commission Regulation (EU) 2017/1151 as Regards the Emission Type Approval Procedures for Light Passenger and Commercial Vehicles," Comitology Register, July 22, 2022, <https://ec.europa.eu/transparency/comitology-register/screen/documents/082562/2/consult?lang=en>.

2 European Commission, "Commission Regulation (EU) 2017/1151 of 1 June 2017 Supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on Type-Approval of Motor Vehicles with Respect to Emissions from Light Passenger and Commercial Vehicles (Euro 5 and Euro 6) and on Access to Vehicle Repair and Maintenance Information, Amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and Repealing Commission Regulation (EC) No 692/2008," Pub. L. No. OJ L 157,01.06.2017, 1 (2017), <http://data.europa.eu/eli/reg/2017/1151/oj>.

3 European Commission, "Commission Regulation (EU) 2018/1832 of 5 November 2018 Amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) 2017/1151 for the Purpose of Improving the Emission Type Approval Tests and Procedures for Light Passenger and Commercial Vehicles, Including Those for in-Service Conformity and Real-Driving Emissions and Introducing Devices for Monitoring the Consumption of Fuel and Electric Energy," Pub. L. No. OJ L 301, 27.11.2018, 1 (2018), <http://data.europa.eu/eli/reg/2018/1832/oj>.

4 More details can be found at Peter Mock, "Changes to the Motor Vehicle Type-Approval System in the European Union," (Berlin: ICCT, 2018), <https://theicct.org/publication/changes-to-the-motor-vehicle-type-approval-system-in-the-european-union/>.

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of the European Parliament.⁵ Therefore, amendments can be adopted by approval of the Technical Committee – Motor Vehicles (TCMV), which represents the EU member states. The new amendment will enter into force twenty days after being published in the Official Journal of the European Union. It will apply from September 1, 2023, but manufacturers are given the flexibility to type-approve vehicles under the amended regulation from March 1, 2023, onwards.

STAGES OF EURO 6e EMISSION STANDARD

To quickly introduce the new requirements while taking implementation lead times for the industry into account, the new Euro 6e provisions are introduced in three stages: Euro 6e, Euro 6e-bis, and Euro 6e-bis-FCM. Figure 1 presents the timeline for the introduction of the Euro 6e stages.

TIMELINE

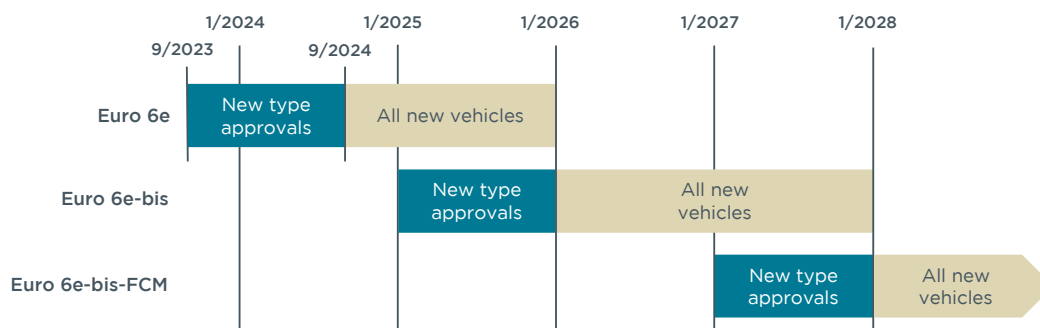


Figure 1. Timeline of Euro 6e introduction for category M1 passenger vehicles and category N1 and N2 light commercial vehicles.

The first Euro 6e stage applies starting from September 2023 for new type-approvals. Manufacturers are given a one-year flexibility until the new stage applies to all new vehicles in September 2024. Registration of Euro 6d vehicles is then no longer possible, except for end-of-series vehicles. The one-year flexibility also applies to the subsequent Euro 6e-bis and Euro 6e-bis-FCM stages, which will enter into force for new types in January 2025 and January 2027, respectively.

Euro 6e requirements will apply to all vehicles categories at the same time, while previous Euro 6 stages were introduced first for passenger vehicles (category M1) and small light commercial vehicles (category N1 class I) and one year later for the remaining light commercial vehicles (category N1 class II/III and category N2). This is likely related to the fact that, for existing vehicle types, manufacturers are not required to perform new type-approval tests when applying for any of the Euro 6e stages. A declaration of compliance by the manufacturer is sufficient and, therefore, the effort required for type-approval is low.

⁵ European Union, “Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (Text with EEA relevance),” Pub. L. No. 32007R0715, 171 OJ L (2007), <http://data.europa.eu/eli/reg/2007/715/2020-09-01>.

OVERVIEW OF KEY CHANGES INTRODUCED BY THE EURO 6e AMENDMENT

The key differences between the three Euro 6e stages and to the currently applicable, final Euro 6d-ISC-FCM stage, are summarized in Table 1 and discussed in more detail in the following sections.

Table 1. Comparison of the Euro 6e emission standards and the final Euro 6d stage. Values highlighted in red have changed compared to the previous emission standard.

	Euro 6d-ISC-FCM	Euro 6e	Euro 6e-bis	Euro 6e-bis-FCM
PHEV utility factor reference distance	800 km	800 km	2200 km	4260 km
PEMS margin for RDE tests	NO _x : 1.43 PN: 1.5	NO _x : 1.10 PN: 1.34	NO _x : 1.10 PN: 1.34	NO _x : 1.10 PN: 1.34
RDE normal temperature range	0°C–30°C	0°C–30°C	0°C– 35°C	0°C–35°C
RDE extended temperature range	-7°C–0°C & 30°C–35°C	-7°C–0°C & 30°C–35°C	-7°C–0°C & 35°C–38°C	-7°C–0°C & 35°C–38°C
Auxiliary Emission Strategy indicator	No	No	Yes	Yes
Vehicle categories having OBFM	M1 (cars), N1 (light vans)	M1, N1, N2 (heavy vans)	M1, N1, N2	M1, N1, N2

Notes: Values highlighted in red have changed compared to the previous emission standard. PHEV: Plug-in hybrid electric vehicle; PEMS: Portable emissions measurement system; RDE: Real driving emissions; NO_x: Nitrogen oxides; PN: Particle number; OBFM: On-board fuel and energy consumption monitoring.

ADJUSTMENT OF PLUG-IN HYBRID VEHICLE UTILITY FACTOR

For determining the official CO₂ emission value of plug-in hybrid electric vehicles (PHEVs), CO₂ emissions are measured in two operating modes: a) when driving with a fully charged battery until depletion and b) when driving with an empty battery. The measured CO₂ emissions are then weighted using a utility factor (UF), which depends on the range a PHEV can cover in battery depleting operation.⁶ The shape of the UF curve is characterized by ten coefficients and a reference distance.

Over the past several years, it has become evident that the currently used UF curve does not reflect the real usage of PHEVs resulting in unrepresentatively low official CO₂ emission values. This leads to an excessive gap between the real-world fuel consumption and the official value determined during type-approval.⁷ As this undermines the European Commission's CO₂ reduction targets and misleads consumers, the European Commission adjusted the UF curve in Euro 6e to reflect more realistic values.

6 Jan Dornoff, "Plug-in Hybrid Vehicle CO₂ Emissions: How They Are Affected by Ambient Conditions and Driver Mode Selection," (Berlin: ICCT, 2021), <https://theicct.org/publications/phev-co2-emissions-ambient-conditions-dec2021>.

7 Patrick Plötz, Cornelius Moll, Yaoming Li, Georg Bieker, and Peter Mock, "Real-World Usage of Plug-in Hybrid Electric Vehicles: Fuel Consumption, Electric Driving, and CO₂ Emissions," (Washington, DC: ICCT, 2020), <https://theicct.org/publication/real-world-usage-of-plug-in-hybrid-electric-vehicles-fuel-consumption-electric-driving-and-co2-emissions/>; Patrick Plötz, Steffen Link, Hermann Ringelschwendner, Marc Keller, Cornelius Moll, Georg Bieker, Jan Dornoff, and Peter Mock "Real-World Usage of Plug-in Hybrid Vehicles in Europe: A 2022 Update on Fuel Consumption, Electric Driving, and CO₂ Emissions," (Washington, DC: ICCT, 2022), <https://theicct.org/publication/real-world-pha-use-jun22/>.

The UF curve is adjusted by increasing the reference distance while keeping the coefficients constant and is done in two-steps, as shown in Figure 2. For stage Euro 6e, the UF curve remains unchanged with a reference distance of 800 km. In stage Euro 6e-bis, the UF curve is adjusted by increasing the reference distance to 2,200 km to reflect the average real-world usage of today's privately owned PHEVs. Two years later, with stage Euro 6e-bis-FCM, the UF curve will be adjusted once more, using a reference distance of 4,260 km, which reflects today's fleet-average usage in Europe of both privately owned vehicles and company cars. The Euro 6e-bis-FCM adjustment is subject to a review by the end of 2024 and will take into account real-world data collected from on-board fuel and energy consumption meters (OBFCM)⁸.

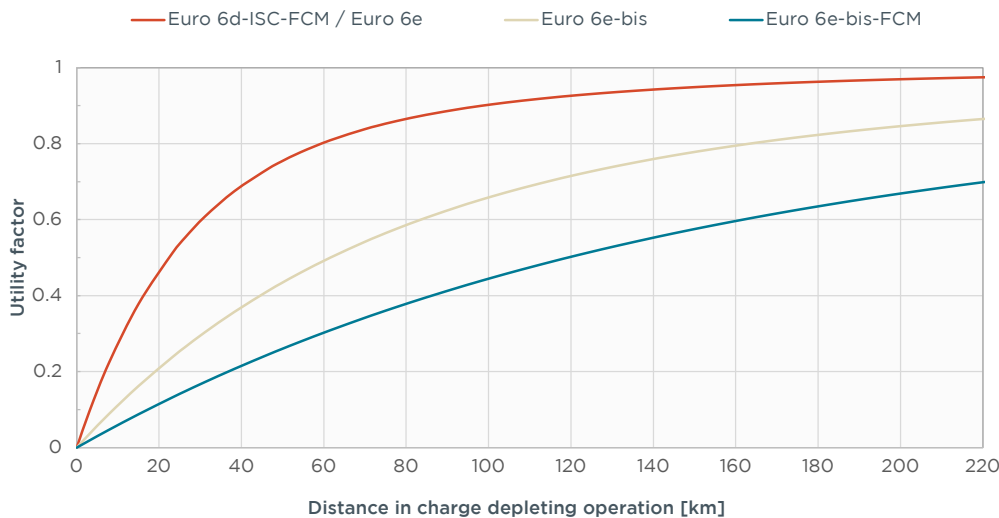


Figure 2. Curve for determining the utility factor based on the range a PHEV can cover in charge depleting operation. In two steps, the curve will be adjusted to reflect better the real-world usage of PHEVs.

To illustrate how the revised UF curves affect the official CO₂ emission values of PHEVs, we analyzed the effect on a BMW X1 xDrive25e PHEV, recently tested by ICCT. The vehicle can drive a distance in charge depleting operation of about 70 km. Using the current UF curve, this results in an official CO₂ emission value of approximately 45 g/km. When applying the Euro 6e-bis UF, the CO₂ emission value of the BMW X1 will almost double to 96 g/km. Using the final Euro 6e-bis-FCM curve results in a CO₂ emission value of about 122 g/km.

CHANGES TO THE LABORATORY TYPE-APPROVAL TEST PROCEDURE

The Euro 6e regulation amendment also contains a revision of the Worldwide Harmonized Light Vehicles Test Procedure (WLTP). Besides minor modifications to improve clarity and unambiguity, the type of regulation, and thereby how it applies to the EU type-approval regulation, was changed.

⁸ European Commission, "Commission Implementing Regulation (EU) 2021/392 of 4 March 2021 on the Monitoring and Reporting of Data Relating to CO₂ Emissions from Passenger Cars and Light Commercial Vehicles Pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council and Repealing Commission Implementing Regulations (EU) No 1014/2010, (EU) No 293/2012, (EU) 2017/1152 and (EU) 2017/1153," Pub. L. No. (EU) 2021/392, 77 L 8 (2021), 392, http://data.europa.eu/eli/reg_impl/2021/392/oj.

The WLTP was developed as Global Technical Regulation No 15 (GTR 15) by the United Nations Economic Council for Europe (UNECE) and was introduced in the EU type-approval regulation in 2017 and amended at the end of 2018 with the WLTP Second Act.⁹ As a Global Technical Regulation, the UNECE WLTP provisions had to be transposed to EU law. This changes with the Euro 6e amendment because it can directly refer to the newly developed UNECE WLTP Regulation No 154 (UN R 154) which does not require transposition.¹⁰

Compared to the current type-approval regulation, most changes to the WLTP introduced by Euro 6e address details of the test procedure based on lessons learned from applying it for type-approval. A notable improvement was made in the test procedure for electric vehicles by unambiguously defining what normal charging of the traction battery means: that it must be charged at the highest power supported by the vehicle and using the on-board charger. However, the regulation fails to specify that normal charging is applied when recharging the vehicle after testing, which is the relevant charging event for determining the electric energy consumption.

CHANGES TO THE REAL DRIVING EMISSIONS PROVISIONS

The success of the Real Driving Emissions (RDE) regulation in reducing real-world pollutant emissions in the EU has led to the development of an RDE regulation by the UNECE,¹¹ largely based on the EU rules. With the Euro 6e amendment, the text of the EU type-approval regulation aligns with the proposed UN regulation text. In addition to restructuring of the text for improved clarity, the changes described below were introduced.

LOWER CONFORMITY FACTOR FOR REAL-DRIVING TESTS

When developing the real-driving test procedure, the European Commission introduced a conformity factor (CF), which was intended to account for the measurement uncertainty of the portable emission measurement system (PEMS). The CF substantially relaxes the Euro 6 nitrogen oxides (NO_x) and particle number (PN) emission limits.

In December 2018, the General Court of the European Union decided that the European Commission infringed on the Euro standards regulation (EC) 2007/715 when introducing a CF of such magnitude.¹² As consequence, the CF was revised based on an extensive study performed by the Joint Research Centre (JRC) of the

9 United Nations Economic Commission for Europe, “Global Technical Regulations (GTRs) - 1998 Agreement on Global Technical Regulations (GTRs),” accessed October 11, 2022, <https://unece.org/transport/standards/transport/vehicle-regulations-wp29/global-technical-regulations-gtrs>.

10 European Union, “Acts Adopted by Bodies Created by International Agreements - UN Regulation No 154,” Pub. L. No. UN Regulation No 154, 423 L 1 (2021), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:42021X2039&from=DE>.

11 United Nations Economic Commission for Europe, “Proposal for a New UN Regulation No. [XXX] on Uniform Provisions Concerning the Approval of Light Duty Passenger and Commercial Vehicles with Regards to Real Driving Emissions (RDE) - Proposal Incorporating Final Euro 6e Text,” GRPE-86-45 based on ECE/TRANS/WP.29/2020/120 § (2022), https://unece.org/sites/default/files/2022-07/GRPE-86-45e_clean.pdf.

12 General Court of the European Union, Judgment in Cases T-339/16 Ville de Paris v Commission, T-352/16 Ville de Bruxelles v Commission, T- 391/16 Ville de Madrid v Commission (General Court of the European Union December 13, 2018).

European Commission,¹³ and the new CFs of 1.10 for NO_x and 1.32 for PN emissions are introduced with Euro 6e. To reflect its purpose more clearly, the CF is also renamed to PEMS margin.

TESTS CAN BE VALID EVEN WHEN OUTSIDE CERTAIN BOUNDARY CONDITIONS

Under the current regulation, if the ambient conditions or duration of stop periods are outside the defined boundaries during an RDE test, the test is invalid. To increase the number of valid tests, and thereby reduce the testing burden, a test violating these conditions will be considered valid if the emission limits are not exceeded.

AMBIENT TEMPERATURE RANGE WIDENED

From Euro 6e-bis onwards, the upper extended ambient temperature range will be raised from 30°C–35 °C to 35°C–38°C. Subsequently, the temperature range considered normal widens from the current 0°C–30°C to 0°C–35°C. No emissions deterioration between 30°C and 35°C will be allowed, compared to the 60 % higher emissions that are currently tolerated.

ENABLE INDEPENDENT IN-SERVICE CONFORMITY TESTING AND TRANSPARENCY

To enable independent actors to perform RDE in-service conformity (ISC) tests, the new amendment introduces the requirement for manufacturers to support PEMS testing by vehicle design, specifically by providing guidance and unrestricted access to exhaust system adapters.

Third parties can obtain reports from manufacturers and type approval authorities of RDE tests performed during type-approval. These reports are required to be provided free of charge and within 10 days instead of the 30 days defined in the current regulation. However, while every interested party can request the reports under the current regulation, the no-charge provision and lead time limit will only apply to the request of third parties as defined in regulation (EU) 163/2022.¹⁴

IN-SERVICE CONFORMITY TESTING BY THIRD PARTIES

Manufacturers and the authorities granting a vehicles type-approval are obliged to perform in-service conformity (ISC) testing. In addition, the type-approval framework regulation (EU) 2018/858 also allows other type-approval authorities, technical services, the European Commission, and other third parties to perform ISC checks.

The Euro 6e amendment implements independent ISC testing in the type-approval procedure and requires manufacturers to provide the data necessary for testing to these parties. Non-compliance detected during independent ISC testing leads to the same remedy procedure as if discovered by the granting type-approval authority.

¹³ Barouch Giechaskiel, Victor Valverde, and Michaël Clairotte, "Real Driving Emissions (RDE): 2020 Assessment of Portable Emissions Measurement Systems (PEMS) Measurement Uncertainty," JRC Technical Report (Luxembourg: Publications Office of the European Union, 2021), <https://data.europa.eu/doi/10.2760/440720>.

¹⁴ The term "third party" is defined in (EU) 163/2022 as non-governmental and non-profitmaking natural or legal persons that are not involved in vehicle type-approval or vehicle development, that have recourse to adequate testing facilities and that declare that all manufacturer data is kept confidential.

TRANSPARENCY LIST CHANGES

To allow independent ISC checks, manufacturers are required to make available to the public the list of vehicle parameters that are necessary for vehicle selection and to perform the tests. The requirement for providing these transparency lists was introduced through amendment (EU) 2018/1832.

With the Euro 6e amendment, the European Commission substantially revises and reduces the content of the transparency list, requiring manufacturers to provide only the absolute minimum information to conduct the tests. All relevant parameters related to electric motors and the traction batteries are removed from the transparency list. In addition, all information about the vehicles constituting the CO₂ interpolation family of the test vehicle is removed, even though it is essential for risk-based test vehicle selection and for efficient screening of the emission performance of the full range of vehicles that can be part of the same interpolation family.

MONITORING OF THE USE OF AUXILIARY EMISSION STRATEGIES

The type-approval regulation allows manufacturers to apply auxiliary emission strategies (AES) only to avoid sudden and irreparable damage of the combustion engine. Activating an AES usually results in increased pollutant emission levels and may therefore be used only under very limited conditions and short period of time. Using an unauthorized AES or activating an AES outside the approved conditions constitutes a defeat device.

To allow for monitoring the AES utilization, vehicles from stage Euro 6e-bis onwards are required to be equipped with an indicator that shows when and which AES is active, accessible at the on-board diagnostic interface.

SUMMARY AND OUTLOOK

With the Euro 6e amendment, the European Commission aligns the type-approval procedure regulation with continued WLTP and RDE regulation developments at the UNECE. By adjusting the utility factor, the European Commission takes the important step of making the official CO₂ emissions of PHEVs more representative of their real-world emissions. In addition, extending the temperature range for RDE tests will ensure that vehicles comply with emission limits at the summer temperatures frequently encountered in Europe. By defining provisions for in-service conformity checks by third parties and other independent actors, and by introducing an indicator for the activation of auxiliary emission strategies, this amendment to the type-approval procedure regulation can help to monitor the pollutant emissions performance of in-use vehicles more closely and more effectively.

Important improvements were made with the Euro 6e amendment. However, Euro 6e also missed the following opportunities to improve transparency and reduce the negative impact of light duty vehicles on air pollution and climate change:

- » Only plug-in hybrid electric vehicles are currently required to measure real-world electric energy consumption using on-board fuel and energy consumption monitoring (OBFCEM), whereas battery electric vehicles will remain excluded with Euro 6e.

- » Although OBFCM data will be used for Euro 6e-bis-FCM to verify the PHEV utility factor adjustment, no accuracy requirements exist for any of the relevant OBFCM parameters.¹⁵
- » Runtime counters, which are necessary to assess whether auxiliary emission strategies (AES) are used extensively, are not required in Euro 6e.
- » Transparency list data, which is deemed public information by the regulation, is collected and stored in a central database by the European Commission. However, access to the database is not provided to the public, even though it would greatly simplify third party vehicle testing.
- » A PHEV charge increasing mode, where the battery is charged using the combustion engine, which entails extreme CO₂ emissions, is still allowed in Euro 6e.¹⁶ In addition, the current real driving emission (RDE) test provisions make it highly unlikely that valid in-service conformity tests can be performed with PHEVs in this mode.
- » Under Euro 6e, battery electric vehicles will only be tested at room temperature and with deactivated air conditioning despite evidence that range and energy consumption deteriorate substantially under real-world conditions.

More details and suggestions for improvement can be found in our feedback to the Euro 6e public consultation.¹⁷ Fortunately, the Euro 7 emission standards currently being negotiated provide a new opportunity to address these open issues.

15 Jan Dornoff and Nikiforos Zacharof, "Coming Back to Reality: A Proposal for Real-World Accuracy Requirements for Vehicle on-Board Fuel and Energy Consumption Monitoring," (Washington, DC: ICCT, 2022), <https://theicct.org/publication/obfcm-accuracy-verification-feb22/>.

16 Dornoff, "Plug-in Hybrid Vehicle CO₂ Emissions: How They Are Affected by Ambient Conditions and Driver Mode Selection."

17 "Feedback from: International Council on Clean Transportation," Have your say - Light-duty vehicles - updates on type approval testing procedures, June 17, 2022, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13483-Light-duty-vehicles-updates-on-type-approval-testing-procedures/F3314017_en.