II

(Non-legislative acts)

REGULATIONS

COMMISSION REGULATION (EU) 2023/443

of 8 February 2023

amending Regulation (EU) 2017/1151 as regards the emission type approval procedures for light passenger and commercial vehicles

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to 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 [1], and in particular Articles 5(3) and 14(3) thereof,

Whereas:

(1) Regulation (EC) No 715/2007 regulates type approval of motor vehicles with regard to their emissions. To that end, it requires new light passenger and commercial vehicles to comply with certain emission limits. The specific technical provisions necessary to implement that Regulation are contained in Commission Regulation (EU) 2017/1151 [2]. Given that Regulation (EU) 2018/858 of the European Parliament and of the Council [3] regulates the type approval of motor vehicles, it is appropriate to align the definitions of Commission Regulation (EU) 2017/1151 with those of Regulation (EU) 2018/858 in order to achieve a uniform understanding in type approval legislation [2].

(2) The provisions on access to vehicle on-board diagnostics (OBD) information and vehicle repair and maintenance information laid out in Chapter III of Regulation EC No 715/2007 have been integrated in Chapter XIV of Regulation (EU) 2018/858, which applies since 1 September 2020. In order to align the legislation, it is appropriate to delete, the provisions in Regulation (EU) No 2017/1151 relating to access to such information.

(3) Since the introduction of the real driving emission (RDE) methodology in the requirements for vehicle testing by Regulation (EU) 2016/427, which was taken over in Annex IIIA to Regulation (EU) 2017/1151, all vehicles may be tested at low ambient temperatures. The specific requirement to present information that the nitrogen oxides (NOx) pollution control devices reach sufficiently high temperature within 400 seconds at – 7 °C is therefore redundant and should be deleted.

[1] OJ L 171, 29.6.2007, p. 1.

[2] 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 Regulation (EC) No 692/2008 (OJ L 175, 7.7.2017, p. 1).

[3] Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC (OJ L 151, 14.6.2018, p. 1).

(4) In order to allow monitoring the consumption of fuel and/or electric energy for all types of vehicles covered by this Regulation, the requirements for such monitoring should apply to vehicles of N_2 category. As this is a new requirement for that category, it is appropriate to allow vehicle manufacturers sufficient time to comply with that requirement.

(5) In order to identify whether a tested vehicle operates in the base emission strategy (BES) or in an auxiliary emission strategy (AES) an appropriate indication of AES activation should be introduced in vehicles informing when an AES is used. Therefore, appropriate lead time is needed in order to introduce such indicator in all new vehicles.

(6) A formal documentation package should be made available to allow other type approval authorities, technical services, third parties, the Commission or market surveillance authorities to understand whether higher emissions than expected during testing under certain conditions could be attributed to an AES.

(7) Given that Regulation (EU) 2018/858 allows third parties for the in-service conformity (ISC) testing, the provisions for ISC checks need to be adapted.

(8) The application of ISC checks is to be facilitated by an electronic platform on ISC. The development of this platform showed the need for certain changes in the transparency lists. At the same time, the transparency lists should be streamlined to contain only the necessary elements for ISC testing.

(9) A UN Regulation on Real Driving Emissions (RDE) is being developed in the UN World Forum for Harmonization of Vehicle Regulations with improvements in the structure and other elements of the RDE methodology. Those improvements have not yet been formally adopted, but as they represent the latest technical developments, it is necessary to introduce them in Regulation (EU) 2017/1151.

(10) The Joint Research Centre published two review reports in 2020 ([4]) and 2021 ([5]) on the assessment of the PEMS margins used in the RDE procedure representing the latest state of knowledge on the performance of portable emission measurement systems. It is therefore appropriate to lower the PEMS margins in line with the best available scientific knowledge contained in these reports. The lowering of the PEMS margins should be accompanied by changes in the methodology of the calculation of the results of an RDE test.

(11) The Worldwide Harmonised Light-duty Test Procedure (WLTP) was first adopted in the UN World Forum for Harmonization of Vehicle Regulations as Global Technical Regulation (GTR) No 15 ([6]) and later as UN Regulation No 154 ([7]). Certain amendments have been introduced to the WLTP methodology in the UN in order to take into account the latest developments of technical progress. It is therefore appropriate to align the WLTP methodology laid down in Regulation (EU) 2017/1151 with the UN Regulation.

(12) UN Regulation No 154 covers two sets of regional requirements, termed Level 1A and Level 1B. Although the majority of the requirements of that UN Regulation are applicable to both Level 1A and Level 1B, certain of them are specific to a particular level. For application of UN Regulation No 154 in the Union, only the level 1A requirements are relevant as only this level is based on the four phase test cycle (low, medium, high and extra-high speed) used in the Union.

([4]) Valverde Morales, V., Giechaskiel, B. and Carriero, M., Real Driving Emissions: 2018-2019 assessment of Portable Emissions Measurement Systems (PEMS) measurement uncertainty, EUR 30099 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-16364-0, doi:10.2760/684820, JRC114416.

([5]) Giechaskiel, B., Valverde Morales, V. and Clairotte, M., Real Driving Emissions (RDE): 2020 assessment of Portable Emissions Measurement Systems (PEMS) measurement uncertainty, EUR 30591 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-30230-8, doi:10.2760/440720, JRC124017.

([6]) Global technical regulation No 15 on Worldwide harmonized Light vehicles Test Procedure.

([7]) UN Regulation No 154 – Uniform provisions concerning the approval of light duty passenger and commercial vehicles with regards to criteria emissions, emissions of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range (WLTP) (OJ L 290, 10.11.2022, p. 1).

(13) To minimise complexity of this Regulation and to avoid duplication of regulatory provisions, rather than transposing the provisions of UN Regulation No 154 by this Regulation, reference to that UN Regulation should be introduced to Regulation (EU) 2017/1151.

(14) Based on recommendations by the Joint Research Centre, it is appropriate to amend the respective test procedure for the conformity of production (CoP) assessment of carbon dioxide (CO_2) emissions of vehicles, including the run-in procedure in order to allow for technical progress.

(15) In order to reduce testing flexibilities, some specific provisions should be introduced, such as provisions on the use of computational fluid dynamics (CFD) simulation tools and its validation, as well as on the setting of a coasting functionality in dynamometer operation.

(16) An additional gearshift calculation tool, developed by the Joint Research Centre, should be introduced as reference tool.

(17) An update to the Type 5 test for verifying the durability of pollution control devices and updated OBD requirements is necessary to take into account the changes related to the WLTP.

(18) Recent studies show a significant difference between the average real-world CO_2 emissions of plug-in hybrid electric vehicles and their CO_2 emissions determined by WLTP. In order to ensure that the CO_2 emissions determined for such vehicles are representative of real driver behaviour, the utility factors applied for the purpose of the CO_2 emission determination at type approval should be revised. As a first step, new utility factors should be specified on the basis of available data. As a second step, those factors should be further revised, taking into account data from fuel consumption monitoring devices on-board such vehicles and collected in accordance with Commission Implementing Regulation (EU) 2021/392 ([8]).

(19) Some requirements introduced in this amendment, such as the indicator for AES activation, require adaptation of the vehicle. Therefore those requirements should be introduced in three distinct steps.

(20) It is therefore appropriate to amend Regulation (EU) 2017/1151.

(21) In order to provide Member States, national authorities and economic operators with sufficient time to prepare for the application of the rules introduced by this Regulation, the date of application of this Regulation should be deferred.

(22) The measures provided for in this Regulation are in accordance with the opinion of the Technical Committee - Motor Vehicles,

HAS ADOPTED THIS REGULATION:

Article 1

Regulation (EU) 2017/1151 is amended as follows:

(1) Article 2 is amended as follows:

(a) the introductory phrase is replaced by the following:

'For the purposes of this Regulation, the definitions in Regulation (EU) 2018/858 (*) of the European Parliament and of the Council shall apply.

(*) Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC (OJ L 151, 14.6.2018, p. 1).';

([8]) Commission Implementing Regulation (EU) 2021/392 of 4 March 2021 on the monitoring and reporting of data relating to CO_2 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 (OJ L 77, 5.3.2021, p. 8).

The following definitions shall also apply:

(b) point 1 is amended as follows:

(1) the introductory phrase is replaced by the following:

‘ “vehicle type with regard to emissions” means a group of vehicles which:’;

(2) point (a) is replaced by the following:

‘(a) do not differ with respect to the criteria constituting an “interpolation family” as specified in paragraph 6.3.2 of UN Regulation No 154 (*);

(*) UN Regulation No 154 – Uniform provisions concerning the approval of light duty passenger and commercial vehicles with regards to criteria emissions, emissions of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range (WLTP) (OJ L 290, 10.11.2022, p. 1).’

(3) point (b) is replaced by the following:

‘(b) fall in a single “CO_2 interpolation range” within the meaning of paragraph 2.3.2 of Annex B6 to UN Regulation No 154 or paragraph 4.5.1. of Annex B8 to UN Regulation 154;’;

(4) in point (c), the second indent is replaced by the following:

‘— exhaust gas recirculation (with or without, internal/external, cooled/non-cooled, low/high/combined pressure)’;

(c) point 2 is replaced by the following:

‘(2) “EC type-approval of a vehicle with regard to emissions” means an EU type-approval of the vehicles with regard to their tailpipe emissions, crankcase emissions, evaporative emissions and fuel consumption;’;

(d) point 8 is amended as follows:

(a) point (a) is replaced by the following:

‘(a) number and kind of substrates, structure and material;’

(b) the following point (i) is added:

‘(i) required reagent (if applicable);’;

(e) point 10 is replaced by the following:

‘(10) “mono fuel gas vehicle” means a mono-fuel vehicle that is designed primarily for permanent running on LPG or NG/biomethane or hydrogen, but may also have a petrol system for emergency purposes or starting only, where the nominal capacity of the petrol tank does not exceed 15 litres;’;

(f) point 11 is replaced by the following:

‘(11) “bi-fuel vehicle” means a vehicle with two separate fuel storage systems that is designed to run primarily on only one fuel at a time most of the time;’;

(g) point 17 is replaced by the following:

‘(17) “properly maintained and used” means, for the purpose of a test vehicle, that such a vehicle satisfies the criteria for acceptance of a selected vehicle laid down in Appendix 1 of Annex II’;

(h) point 20 is replaced by the following:

'(20) "malfunction" means the failure of an emission-related component or system that would result in emissions exceeding the thresholds in Table 4A of paragraph 6.8.2 of UN Regulation No 154 or if the OBD system is unable to fulfil the basic monitoring requirements set out in Annex C5 to UN Regulation No 154;';

(i) point 22 is replaced by the following:

'(22) "driving cycle" means, in respect of vehicle OBD systems, the key-on, a driving mode where a malfunction would be detected if present, and key-off';

(j) point 23 is deleted;

(k) the following point 23a is inserted:

'(23a) "third party" means a third party complying with the requirements of Commission Implementing Regulation (EU) 2022/163 (*)

(*) Commission Implementing Regulation (EU) 2022/163 of 7 February 2022 laying down the rules on the application of Regulation (EU) 2018/858 of the European Parliament and of the Council as regards functional requirements for market surveillance of vehicles, systems, components and separate technical units (OJ L 27, 8.2.2022, p. 1).';

(l) point 25 is replaced by the following:

'(25) "deteriorated replacement pollution control device" means a pollution control device as defined in Article 3(11) of Regulation (EC) No 715/2007 that has been aged or artificially deteriorated to such an extent that it fulfils the requirements laid out in paragraph 1 of Appendix 1 of Annex C4 to UN Regulation No 154';

(2) Article 3 is amended as follows:

(a) paragraph 1 is replaced by the following:

'1. In order to receive an EC type-approval with regard to emissions, the manufacturer shall demonstrate that the vehicles comply with the requirements of this Regulation when tested in accordance with the test procedures specified in Annexes IIIA to VIII, XI, XVI, XX, XXI and XXII. The manufacturer shall also ensure that the reference fuels comply with the specifications set out in Annex IX.';

(b) in paragraph 2, the following subparagraph is added:

'In all references to UN Regulation No 154, only the European Union related requirements characterised by level 1A shall apply. References in UN Regulation No 154 to "criteria emissions" shall be understood as references to "pollutant emissions" in this Regulation.';

(c) in paragraph 3, the second subparagraph is replaced by the following:

'The emissions tests for roadworthiness purposes set out in Annex IV and the tests for fuel consumption and CO_2 emissions set out in Annex XXI shall be required to obtain EC type-approval with regard to emissions under this paragraph.';

(d) paragraph 7 is replaced by the following;

'7. Mono-fuel gas vehicles shall be tested in the Type 1 test for variation in the composition of either LPG or NG/biomethane, as set out in Annex B6 to UN Regulation No 154 for pollutant emissions, with the fuel used for the measurement of the net power in accordance with Annex XX of this Regulation.

Bi-fuel gas vehicles shall be tested with petrol and either LPG or NG/biomethane. The tests on LPG or NG/biomethane shall be performed for variation in the composition of LPG or NG/biomethane, as set out in Annex B6 to UN Regulation No 154 for pollutant emissions, and with the fuel used for the measurement of the net power in accordance with Annex XX of this Regulation.'

(e) paragraph 10, second and fifth subparagraph are deleted;

(f) paragraph 11, the first and the second subparagraph are replaced by the following:

'11. The manufacturer shall ensure that, throughout the normal life of a vehicle which is type approved in accordance with Regulation (EC) No 715/2007, its final RDE emission results as determined in accordance with Annex IIIA and emitted at any Type 1a test performed in accordance with that Annex, do not exceed the emission limits for NOx and PN.

Type approval in accordance with Regulation (EC) No 715/2007 may only be issued if the vehicle is part of a validated PEMS test family in accordance with point 3.3 of Annex IIIA.';

(3) In Article 4, paragraphs 4, 5 and 6 are replaced by the following:

'4. When tested with a defective component in accordance with Appendix 1 of Annex C5 to UN Regulation No 154, the OBD system malfunction indicator shall be activated.

The OBD system malfunction indicator may also activate during this test at levels of emissions below the OBD thresholds specified in Table 4A of paragraph 6.8.2 of UN Regulation No 154.

5. The manufacturer shall ensure that the OBD system complies with the requirements for in-use performance set out in Section 1 of Appendix 1 to Annex XI under all reasonably foreseeable driving conditions.

6. In-use performance related data to be stored and reported by a vehicle's OBD system according to the provisions of Section 1 of Appendix 1 to Annex XI shall be made readily available by the manufacturer to national authorities and independent operators without any encryption.';

(4) In Article 4a, the –introductory phrase is replaced by the following:

'The manufacturer shall ensure that the following vehicles of categories M1, N1 and N2 are equipped with a device for determining, storing and making available data on the quantity of fuel and/or electric energy used for the operation of the vehicle:';

(5) Article 5 is amended as follows:

(a) the title is replaced by:

'Application for EC type-approval of a vehicle with regard to emissions';

(b) paragraph 1 is replaced by the following:

'1. The manufacturer shall submit to the approval authority an application for EC type-approval of a vehicle with regard to emissions.';

(c) paragraph 3 is amended as follows:

(1) point (a) is replaced by the following:

'(a) in the case of vehicles equipped with positive-ignition engines, a declaration by the manufacturer of the minimum percentage of misfires out of a total number of firing events that either would result in emissions exceeding the OBD thresholds laid out in Table 4A of paragraph 6.8.2 of UN Regulation No 154 if that percentage had been present from the start of a type 1 test as chosen for the demonstration in accordance with Annex C5 to UN Regulation No 154 or could lead to an exhaust catalyst, or catalysts, overheating prior to causing irreversible damage;';

(2) points (d) to (g) are replaced by the following:

'(d) a declaration by the manufacturer that the OBD system complies with the provisions of section 1 of Appendix 1 to Annex XI relating to in-use performance under all reasonably foreseeable driving conditions;

(e) a plan describing the detailed technical criteria and justification for incrementing the numerator and denominator of each monitor that must fulfil the requirements of paragraphs 7.2 and 7.3. of Appendix 1 to Annex C5 of UN Regulation No 154, as well as for disabling numerators, denominators and the general denominator under the conditions outlined in paragraph 7.7 of Appendix 1 to Annex C5 of UN Regulation No 154;

(f) a description of the provisions taken to prevent tampering with and modification of the emission control systems, including the emission control computer and odometer including the recording of mileage values for the purposes of the requirements of Annexes XI and XVI;

(g) if applicable, the particulars of the vehicle family as referred to in paragraph 6.8.1. of UN Regulation No 154;';

(d) in paragraph 6, the first and the second subparagraph are replaced by the following:

'For the purposes of paragraph 3, points (d) and (e), approval authorities shall not approve a vehicle if the information submitted by the manufacturer is inappropriate for fulfilling the requirements of section 1 of Appendix 1 to Annex XI.

Paragraphs 7.2, 7.3 and 7.7 of Appendix 1 to Annex C5 of UN Regulation No 154 shall apply under all reasonably foreseeable driving conditions.';

(e) paragraph 11 is amended as follows:

(a) the following second subparagraph is inserted:

'For vehicles approved under the character EB and EC as defined in Table 1, Appendix 6 to Annex I, the manufacturer shall introduce an indicator (AES Flag or Timer) to indicate when a vehicle runs in AES mode instead of BES mode. The indicator shall be available via the serial port of a standard diagnostic connector upon request of a generic scan-tool. The AES that is running shall be identifiable via the formal documentation package.'

(b) the sixth subparagraph is replaced by the following:

'The approval authority may test the functioning of AES.'

(c) the following subparagraphs are added:

'A list of AES which were deemed non-acceptable by type approval authorities shall be compiled yearly by the Forum for Exchange of Information on Enforcement and made available to the public by the Commission at the latest by end of March of the following year, in case there were AES which were deemed non-acceptable.

The manufacturer shall also provide to the approval authorities a formal documentation package, as in Appendix 3a to Annex I, containing information on AES/BES that would allow an independent tester to identify if the emissions measured can be attributed to an AES or BES strategy or are potentially due to a defeat device. The formal documentation package shall be made available to all type approval authorities, technical services, market surveillance authorities, third parties and the Commission upon request.

Vehicles of category M1 or N1 shall be approved with emission characters EA, EB or EC as specified in Table 1, Appendix 6 to Annex I, taking into account the utility factors determined in accordance with the values specified in Table A8.App5/1 of point 3.2. of Annex XXI.';

(f) paragraph 12 is replaced by the following:

'12. The manufacturer shall also provide the type approval authority which granted the emission type-approval under this Regulation ("granting type approval authority") with a package on testing transparency containing the necessary information in order to allow the performance of testing in accordance with point 5.9 of Annex II.

Once the electronic platform for ISC is ready, the manufacturer shall also upload all required data into the platform for all its vehicles. The information in the transparency lists shall be limited to the prescribed information required by Appendix 5 of Annex II.'

(6) Article 6 is amended as follows:

(a) the title is replaced by the following:

'Administrative provisions for EC type-approval of a vehicle with regard to emissions';

(b) paragraph 1 is replaced by the following:

'1. If all the relevant requirements are met, the approval authority shall grant an EC type-approval and issue a type-approval number in accordance with the numbering system set out in Annex IV to Commission Implementing Regulation (EU) 2020/683 (*).

Without prejudice to the provisions of Annex IV to Regulation (EU) 2020/683, Section 3 of the type-approval number shall be drawn up in accordance with Appendix 6 to Annex I.

An approval authority shall not assign the same number to another vehicle type.

(*) Commission Implementing Regulation (EU) 2020/683 of 15 April 2020 implementing Regulation (EU) 2018/858 of the European Parliament and of the Council with regards to the administrative requirements for the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (OJ L 163, 26.5.2020, p. 1).;'

(c) paragraph 2 is replaced by the following:

'2. By way of derogation from paragraph 1, at the request of the manufacturer, a vehicle with an OBD system may be accepted for type-approval with regard to emissions, even though the system contains one or more deficiencies such that the specific requirements of Annex XI are not fully met, provided that the specific administrative provisions set out in Section 3 of that Annex are complied with.

The approval authority shall notify the decision to grant such a type approval to all approval authorities in the other Member States in accordance with the requirements set out in Article 27 of Regulation (EU) 2018/858.';

(7) in Article 7, the first paragraph is replaced by the following:

'Articles 27, 33 and 34 of Regulation 2018/858 shall apply to any amendments to the type-approvals granted in accordance to Regulation (EC) No 715/2007.';

(8) in Article 8, paragraph 1 is replaced by the following:

'1. Measures to ensure the conformity of production shall be taken in accordance with Article 31 of Regulation (EU) 2018/858.

The provisions laid down in Section 4 of Annex I to this Regulation and the relevant statistical method in Appendix 2 of UN Regulation No 154 shall apply.';

(9) Article 9 is amended as follows:

(a) the title is replaced by the following:

'In-service conformity';

(b) paragraph 1 is replaced by the following:

'1. Measures to ensure in-service conformity of vehicles type-approved under this Regulation shall be taken in accordance with the conformity of production arrangements as laid down in Article 31 of Regulation (EU) 2018/858,Annex IV to Regulation (EU) 2018/858 and Annex II to this Regulation.';

(c) in paragraph 4, the second sentence is replaced by the following:

'For such families, the manufacturer shall provide the approval authority with a report of any emissions related warranty and relevant repair as set out in point 4 of Annex II.';

(d) paragraph 5 is replaced by the following:

'5. The manufacturer and the granting type approval authority shall perform in-service conformity checks in accordance with Annex II. Other type approval authorities, technical services, the Commission and third parties may perform parts of the in-service conformity checks in accordance with Annex II. The data required to perform such checks are regulated in the Commission Implementing Regulation 2022/163 (*) and Annex II of this Regulation.

(*) Commission Implementing Regulation (EU) 2022/163 of 7 February 2022 laying down the rules on the application of Regulation (EU) 2018/858 of the European Parliament and of the Council as regards functional requirements for market surveillance of vehicles, systems, components and separate technical units (OJ L 27, 8.2.2022, p. 1).;'

(e) paragraph 7 is replaced by the following:

'7. If a type approval authority, technical service, the Commission or a third party has established that an in-service conformity family fails the in-service conformity check, it shall notify without delay the granting type approval authority, in accordance with Article 54(1) of Regulation (EU) 2018/858.

Following that notification and subject to the provisions of Article 54(5) of Regulation (EU) 2018/858, the granting approval authority shall inform the manufacturer that an in-service conformity family fails the in-service conformity checks and that the procedures laid out in points 6 and 7 of Annex II shall be followed.

If the granting approval authority establishes that no agreement can be reached with a type approval authority that has established that an in-service conformity family fails the in-service conformity check, the procedure pursuant to Article 54(5) of Regulation (EU) 2018/858 shall be initiated.';

(f) paragraph 8 is replaced by the following:

'8. In addition to paragraphs 1 to 7, the following shall apply to vehicles type approved in accordance with Annex II.

(a) vehicles submitted to multi-stage type-approval, as defined in Article 3(8) of Regulation EU 2018/858, shall be checked for in-service conformity in accordance with the provisions for multistage approval set out in point 5.10.6 of Annex II to this Regulation.

(b) hearses as specified in Appendix 1 of Part III of Annex II to Regulation EU 2018/858, armoured vehicles as defined in Appendix 2 of Part III of Annex II to Regulation EU 2018/858 and wheelchair accessible vehicles as defined in Appendix 3 of Part III of Annex II to Regulation EU 2018/858 shall not be subject to the provisions of this Article. All other special purpose vehicles as defined in Appendix 4 of Part III of Annex II to Regulation EU 2018/858, shall be checked for in- service conformity in accordance with the rules for multistage type-approvals set out in Annex II to this Regulation.';

(10) in Article 10, paragraph 1 is replaced by the following:

'1. The manufacturer shall ensure that replacement pollution control devices intended to be fitted to EC type-approved vehicles covered by the scope of Regulation (EC) No 715/2007 are EC type-approved, as separate technical units within the meaning of Article 10(2) of Directive 2007/46/EC, in accordance with Articles 12 and 13 and Annex XIII to this Regulation.

Catalytic converters and particulate filters shall be considered to be pollution control devices for the purposes of this Regulation.

The relevant requirements shall be deemed to be met if the replacement pollution control devices have been approved according to UN/ECE Regulation No 103 (*).

(*) Regulation No 103 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of replacement pollution control devices for power-driven vehicles (OJ L 207, 10.8.2017, p. 30).';

(11) in Article 11 paragraph 3 the second subparagraph is replaced by the following:

'The test vehicles shall comply with the requirements set out in Section 2.3 of Annex B6 to UN Regulation No 154.';

(12) Article 13 is deleted;

(13) Article 14 is deleted;

(14) in Article 15 the following paragraphs 12, 13 and 14 are added:

'12. For vehicle types with an existing valid type approval issued before 1 September 2023, new type approval testing shall not be required if the manufacturer declares to the type approval authority that compliance with the requirements of this Regulation is ensured. Requirements not related to the testing of the vehicle, including required declarations and data requirements, apply.

13. For vehicle types with an existing valid type approval issued according to emission standard Euro 6e (*) for which a manufacturer requests an approval according to emission standard Euro 6e-bis (*), new type approval testing shall not be required if the manufacturer declares to the type approval authority that compliance with the requirements of the Euro 6e-bis emission standard is ensured. Requirements not related to the testing of the vehicle, including required declarations and data requirements, apply.

14. For vehicle types with an existing valid type approval issued according to emission standard Euro 6e-bis for which a manufacturer requests an approval according to emission standard Euro 6e-bis-FCM (*), new type approval testing shall not be required if the manufacturer declares to the type approval authority that compliance with the requirements of the Euro 6e-bis-FCM emission standard is ensured. Requirements not related to the testing of the vehicle, including required declarations and data requirements, apply.

(*) As specified in Appendix 6 to Annex I.'

(15) List of Annexes and Annex I is amended as set out in Annex I to this Regulation;

(16) Annex II is replaced by the text in Annex II to this Regulation;

(17) Annex IIIA is replaced by the text in Annex III to this Regulation;

(18) Annex V is amended as set out in Annex IV to this Regulation;

(19) Annex VI is amended as set out in Annex V to this Regulation;

(20) Annex VII is amended as set out in Annex VI to this Regulation;

(21) Annex VIII is amended as set out in Annex VII to this Regulation;

(22) Annex IX is amended as set out in Annex VIII to this Regulation;

(23) Annex XI is replaced by the text in Annex IX to this Regulation;

(24) Annex XII is amended as set out in Annex X to this Regulation;

(25) Annex XIII is amended as set out in Annex XI to this Regulation;

(26) Annex XIV is deleted;

(27) Annex XVI is replaced by the text in Annex XII to this Regulation;

(28) Annex XX is amended as set out in Annex XIII to this Regulation;

(29) Annex XXI is replaced by the text in in Annex XIV to this Regulation;

(30) Annex XXII is replaced by the text in Annex XV to this Regulation.

Article 2

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

It shall apply from 1 September 2023.

However, from 1 March 2023, national authorities shall not refuse to grant EU type approval for a new type of vehicle or grant extension for an existing type of vehicle, or prohibit registration, placing on the market or entry into service of a new vehicle, where the vehicle concerned complies with this regulation, if a manufacturer so requests.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 8 February 2023.

For the Commission
The President
Ursula VON DER LEYEN

ANNEX I

List of Annexes and Annex I to Regulation (EU) 2017/1151 are amended a follows:

(1) List of Annexes is replaced by the following:

'LIST OF ANNEXES

ANNEX XVIII Amendments to Directive 2007/46/EC

ANNEX XIX Amendments to Regulation (EU) No 1230/2012

ANNEX XX Measurement of net power and the maximum 30 minutes power of electric drive trains

ANNEX XXI Type 1 emissions test procedures

ANNEX XXII Devices for monitoring on board the vehicle the consumption of fuel and/or electric energy'

(2) Annex I is amended as follows:

(a) points 1.1.1. to 4.5.1.4. are replaced by the following:

'1.1.1. The additional requirements for granting of type-approval for mono fuel gas vehicles, and bi-fuel gas vehicles shall be those set out in paragraph 5.9. of UN Regulation No 154. The reference to the information document in paragraph 5.9.1. of UN Regulation No 154 shall be understood as being reference to Appendix 3 of Annex I of this Regulation.

1.2. **Additional requirements for flex fuel vehicles**

The additional requirements for granting of type-approval for flex fuel vehicles shall be those set out in paragraph 5.8. of UN Regulation No 154.

2. ADDITIONAL TECHNICAL REQUIREMENTS AND TESTS

2.1. **Small volume manufacturers**

2.1.1. List of legislative acts referred to in Article 3(3):

Legislative Act	Requirements
The California Code of Regulations, Title 13, Sections 1961(a) and 1961(b)(1)(C)(1) applicable to 2001 and later model year vehicles, 1968.1, 1968.2, 1968.5, 1976 and 1975, published by Barclay's Publishing	Type-approval must be granted under the California Code of Regulations applicable to the most recent model year of light-duty vehicle.

2.2. **Inlets to fuel tanks**

2.2.1. The requirements for inlets to fuel tanks shall be those specified in paragraphs 6.1.5. and 6.1.6. of UN Regulation 154.

2.3. **Provisions for electronic system security**

2.3.1. The requirements for electronic system security of paragraph 6.1.7. of UN Regulation 154 shall be complied with. The effective application of these strategies in protecting the emission control systems may be tested during type approval and/or market surveillance.

2.3.2 Manufacturers shall effectively deter reprogramming of the odometer readings, in the board network, in any powertrain controller as well as in the transmitting unit for remote data exchange if applicable. Manufacturers shall include systematic tamper-protection strategies and write-protect features to protect the integrity of the odometer reading. Methods giving an adequate level of tamper protection shall be approved by the approval authority. The effective application of these strategies in protecting the odometer may be tested during type approval and/or market surveillance.

2.4. **Application of tests**

2.4.1. Figure I.2.4 illustrates the application of the tests for type-approval of a vehicle. The specific test procedures are described in Annexes II, IIIA, IV, V, VI, VII, VIII, XI, XVI, XX, XXI and XXII.

Figure I.2.4

Application of test requirements for type-approval and extensions

Vehicle category	Vehicles with positive ignition engines including hybrids (1) (2)								Vehicles with compression ignition engines including hybrids		Pure electric vehicles	Hydrogen fuel cell vehicles
	Mono fuel				Bi-fuel (3)			Flex-fuel (3)	Mono fuel			
Reference fuel	Petrol	LPG	NG/Biomethane	Hydrogen (ICE)	Petrol	Petrol	Petrol	Petrol	Diesel	Petrol	—	Hydrogen (Fuel Cell)
					LPG	NG/Biomethane	Hydrogen (ICE) (4)	Ethanol (E85)				
Type 1 test (7)	Yes	Yes (5)	Yes (5)	Yes (4)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	—	—
ATCT (14 °C test)	Yes	Yes	Yes	Yes (4)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	—	—
Gaseous pollutants, RDE (Type 1A test)	Yes	Yes	Yes	Yes (4)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	—	—
PN, RDE (Type 1A test)	Yes	—	—	—	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (both fuels)	Yes	Yes	—	—
Idle emissions (Type 2 test)	Yes	Yes	Yes	—	Yes (both fuels)	Yes (both fuels)	Yes (petrol only)	Yes (both fuels)	—	—	—	—
Crankcase emissions (Type 3 test)	Yes	Yes	Yes	—	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	—	—	—	—

Vehicle category	Vehicles with positive ignition engines including hybrids [1] [2]								Vehicles with compression ignition engines including hybrids		Pure electric vehicles	Hydrogen fuel cell vehicles
	Mono fuel				Bi-fuel [3]			Flex-fuel [3]	Mono fuel			
Evaporative emissions (Type 4 test)	Yes	—	—	—	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	—	Yes	—	—
Durability (Type 5 test)	Yes	Yes	Yes	Yes	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes	Yes	—	—
Low temperature emissions (Type 6 test)	Yes	—	—	—	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (both fuels)	—	—	—	—
In-service conformity	Yes	Yes	Yes	Yes	Yes (as at type approval)	Yes (as at type approval)	Yes (as at type approval)	Yes (as at type approval)	Yes	Yes	—	—
OBD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	—
CO_2 emissions, fuel consumption, electric energy consumption and electric range	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	Yes	Yes

Vehicle category	Vehicles with positive ignition engines including hybrids ([1]) ([2])								Vehicles with compression ignition engines including hybrids		Pure electric vehicles	Hydrogen fuel cell vehicles
	Mono fuel				Bi-fuel ([3])			Flex-fuel ([3])	Mono fuel			
Smoke opacity	—	—	—	—	—	—	—	—	Yes ([8])	—	—	—
Engine power	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OBFCM	Yes	—	—	—	—	—	—	Yes (both fuels)	Yes	Yes	—	—

([1]) Specific test procedures for hydrogen vehicles and flex fuel biodiesel vehicles will be defined at a later stage.
([2]) Particulate mass and particle number limits and respective measurement procedures shall apply only to vehicles with direct injection engines.
([3]) When a bi-fuel vehicle is combined with a flex fuel vehicle, both test requirements are applicable.
([4]) Only NO_x emissions shall be determined when the vehicle is running on hydrogen.
([5]) Particulate mass and particle number limits and respective measurement procedures shall not apply.
([6]) The particle number RDE test only applies to vehicles for which Euro 6 PN emission limits are defined in Table 2 of Annex I to Regulation (EC) No 715/2007.
([7]) For applicability of measured components to fuels and vehicle technology and therefore measurement procedures, see the emission limits as defined in Table 2 of Annex I to Regulation (EC) No 715/2007.
([8]) An actual test may not be necessary, see UN Regulation No 24 for details.

3. EXTENSIONS TO TYPE-APPROVALS

3.1. **Extensions for tailpipe emissions (type 1 and type 2 tests and OBFCM)**

3.1.1. The type-approval shall be extended to vehicles if they conform to the requirements of paragraph 7.4. of UN Regulation No 154. The pollutant emissions shall respect the limits set out in Table 2 of Annex I to Regulation (EC) No 715/2007.

3.2. **Extensions for evaporative emissions (type 4 test)**

3.2.1. For tests performed in accordance with Annex 6 to UN/ECE Regulation No 83 [1 day NEDC] or the Annex to Regulation (EC) No 2017/1221 [2 days NEDC] the type-approval shall be extended to vehicles equipped with a control system for evaporative emissions which meet the following conditions:

3.2.1.1. The basic principle of fuel/air metering is the same.

3.2.1.2. The shape of the fuel tank is identical and the material of the fuel tank and liquid fuel hoses are technically equivalent.

3.2.1.3. The worst-case vehicle with regard to the cross-section and approximate hose length shall be tested. Whether non-identical vapour/liquid separators are acceptable is decided by the technical service responsible for the type-approval tests.

3.2.1.4. The fuel tank volume is within a range of ± 10 %.

3.2.1.5. The setting of the fuel tank relief valve is identical.

3.2.1.6. The method of storage of the fuel vapour is identical, i.e. trap form and volume, storage medium, air cleaner (if used for evaporative emission control), etc.

3.2.1.7. The method of purging of the stored vapour is identical (e.g. air flow, start point or purge volume over the preconditioning cycle).

3.2.1.8. The method of sealing and venting of the fuel metering system is identical.

3.2.2. For tests performed in accordance with Annex VI [2 days WLTP] the type-approval shall be extended to vehicles belonging to an approved evaporative emission family as defined in paragraph 6.6.3 of UN Regulation 154.

3.3. **Extensions for durability of pollution control devices (type 5 test)**

3.3.1. The deterioration factors shall be extended to different vehicles and vehicle types, provided that the requirements of paragraph 7.6. of UN Regulation No 154 are complied with.

3.4. **Extensions for on-board diagnostics**

3.4.1. The type-approval shall be extended to vehicles belonging to an approved OBD family as defined in paragraph 6.8.1 of UN Regulation No 154.

3.5 **Extensions for low temperature test (type 6 test)**

3.5.1. Vehicles with different reference masses

3.5.1.1. The type-approval shall be extended only to vehicles with a reference mass requiring the use of the next two higher equivalent inertia or any lower equivalent inertia.

3.5.1.2. For category N vehicles, the approval shall be extended only to vehicles with a lower reference mass, if the emissions of the vehicle already approved are within the limits prescribed for the vehicle for which extension of the approval is requested.

3.5.2. Vehicles with different overall transmission ratios

3.5.2.1. The type-approval shall be extended to vehicles with different transmission ratios only under certain conditions.

3.5.2.2. To determine whether type-approval can be extended, for each of the transmission ratios used in the type 6 test, the proportion,

$$(E) = (V_2 - V_1)/V_1$$

shall be determined where, at an engine speed of 1 000 min^{-1}, V_1 is the speed of the vehicle-type approved and V_2 is the speed of the vehicle type for which extension of the approval is requested.

3.5.2.3. If, for each transmission ratio, E ≤ 8 %, the extension shall be granted without repeating the type 6 test.

3.5.2.4. If, for at least one transmission ratio, E > 8 %, and if, for each gear ratio, E ≤ 13 %, the type 6 test shall be repeated. The tests may be performed in a laboratory chosen by the manufacturer subject to the approval of the technical service. The report of the tests shall be sent to the technical service responsible for the type-approval tests.

3.5.3. Vehicles with different reference masses and transmission ratios

The type-approval shall be extended to vehicles with different reference masses and transmission ratios, provided that all the conditions prescribed in paragraphs 3.5.1 and 3.5.2 are fulfilled.

4. CONFORMITY OF PRODUCTION

4.1. **Introduction**

4.1.1. Every vehicle produced under a Type Approval according to this Regulation shall be so manufactured as to conform to the type approval requirements of this Regulation. The Manufacturer shall implement adequate arrangements and documented control plans and carry-out at specified intervals as given in this regulation the necessary emission, OBFCM and OBD tests to verify continued conformity with the approved type. The approval authority shall verify and agree with these arrangements and control plans of the manufacturer and perform audits and conduct emission, OBFCM and OBD tests at specific intervals, as given in this regulation, at the premises of the manufacturer, including production and test facilities as part of the product conformity and continued verification arrangements as described in Annex IV of Regulation (EU) 2018/858.

4.1.2. The manufacturer shall check the conformity of production by testing the emissions of pollutants (given in Table 2 of Annex I to Regulation (EC) No 715/2007), the emission of CO_2 (along with the measurement of electric energy consumption and, where applicable, the monitoring of the OBFCM device accuracy), the crankcase emissions, evaporative emissions and the OBD in accordance with the test procedures described in Annexes V, VI, XI, XXI and XXII. The verification shall therefore include the tests of types 1, 3, 4, the tests for OBFCM and OBD, as described in section 2.4.

The type approval authority shall keep record for a period of at least 5 years of all the documentation related to the conformity of production test results and shall make it available to the Commission upon request.

The specific procedures for conformity of production are set out in paragraphs 8 and 9 and Appendixes 1 to 4 of UN Regulation No 154, with the following exception:

Table 8/1 in paragraph 8.1.2. of UN Regulation No 154 shall be replaced with:

Table 8/1

Type 1 Applicable Type-1 CoP requirements for the different types of vehicle

Type of vehicle	Pollutant emissions	CO_2 emissions	Electric energy consumption	OBFCM accuracy
Pure ICE	Yes	Yes	Not Applicable	Yes
NOVC-HEV	Yes	Yes	Not Applicable	Yes
OVC-HEV	Yes: CD ([1]) and CS	:CS only	Yes: CD only	Yes: CS
PEV	Not Applicable	Not Applicable	Yes	Not Applicable
NOVC-FCHV	Not Applicable	Not Applicable	Not Applicable	Not Applicable
OVC-FCHV	Not Applicable	Not Applicable	Exempted	Not Applicable

([1]) Only if there is combustion engine operation during a valid CD Type 1 test for CoP verification

The calculation of additional values required for checking the Conformity of Production of electric energy consumption of PEVs and OVC-HEVs is set out in Appendix 8 of Annex B8 to UN Regulation 154.

4.1.8. In case of non-conformity Article 51 of Regulation (EU) 2018/858 shall apply.

4.2.6. Vehicles fitted with eco-innovations

4.2.6.1. In the case of a vehicle type fitted with one or more eco-innovations, within the meaning of Article 11 of Regulation (EU) 2019/631 ([1]) for M1 or for N1 vehicles, the conformity of production shall be demonstrated with respect to the eco-innovations, by checking the presence of the correct eco-innovation(s) in question.

4.5. **Checking the conformity of the vehicle for a Type 3 test**

4.5.1. If a verification of the Type 3 test is to be carried out, it shall be conducted in accordance with the following requirements:

4.5.1.1. When the approval authority determines that the quality of production seems unsatisfactory, a vehicle shall be randomly taken from the family and subjected to the tests described in Annex V.

4.5.1.2. The production shall be deemed to conform if this vehicle meets the requirements of the tests described in Annex V.

4.5.1.3. If the vehicle tested does not satisfy the requirements of Section 4.5.1.1, a further random sample of four vehicles shall be taken from the same family and subjected to the tests described in Annex V. The tests may be carried out on vehicles which have completed a maximum of 15 000 km with no modifications.

4.5.1.4. The production shall be deemed to conform if at least three vehicles meet the requirements of the tests described in Annex V.';

(3) Appendices 1 and 2 are deleted;

([1]) Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (OJ L 111, 25.4.2019, p. 13).

(4) Appendices 3 and 3a are replaced by the following:

'Appendix 3

MODEL

INFORMATION DOCUMENT No …

RELATING TO EC TYPE-APPROVAL OF A VEHICLE WITH REGARD TO EMISSIONS

The following information, if applicable, must be supplied in triplicate and include a list of contents. Any drawings must be supplied in appropriate scale and in sufficient detail on size A4 or on a folder of A4 format. Photographs, if any, must show sufficient detail.

If the systems, components or separate technical units have electronic controls, information concerning their performance must be supplied.

0	GENERAL
0.1.	Make (trade name of manufacturer): …
0.2.	Type: …
0.2.1.	Commercial name(s) (if available): …
0.2.2.1.	Allowed Parameter Values for multistage type approval to use the base vehicle emission, consumption and/or range values (insert range if applicable): Final Vehicle actual mass (in kg): … Final Vehicle technically permissible maximum laden mass (in kg): … Frontal area for final vehicle (in cm2): … Rolling resistance (kg/t): … Cross-sectional area of air entrance of the front grille (in cm2): …
0.2.3.	Family identifiers:
0.2.3.1.	Interpolation family: …
0.2.3.2.	ATCT family(s): …
0.2.3.3.	PEMS family: …
0.2.3.4.	Roadload family
0.2.3.4.1.	Roadload family of VH: …
0.2.3.4.2.	Roadload family of VL: …
0.2.3.4.3.	Roadload families applicable in the interpolation family: …
0.2.3.5.	Roadload Matrix family(s): …

0.2.3.6.	Periodic regeneration family(s): …
0.2.3.7.	Evaporative test family(s): …
0.2.3.8.	OBD family(s): …
0.2.3.9.	Durability family(s): …
0.2.3.10.	ER family(s): …
0.2.3.11.	Gas Fuelled Vehicle family(s): …
0.2.3.12.	—
0.2.3.13.	K_{CO_2} correction factor family: …
0.2.4.	other family(s): …
0.4.	Category of vehicle (c): …
0.5	Name and address of the manufacturer
0.8.	Name(s) and address(es) of assembly plant(s): …
0.9.	Name and address of the manufacturer's representative (if any): …
1	GENERAL CONSTRUCTION CHARACTERISTICS
1.1.	Photographs and/or drawings of a representative vehicle/component/separate technical unit ([1]):
1.3.3.	Powered axles (number, position, interconnection): …
2	MASSES AND DIMENSIONS ([f]) ([g]) ([7]) (in kg and mm) (Refer to drawing where applicable)
2.6.	Mass in running order ([h]) (a) maximum and minimum for each variant: …
2.6.3.	Rotational mass: 3 % of the sum of mass in running order and 25 kg or value, per axle (kg): …
2.8.	Technically permissible maximum laden mass stated by the manufacturer ([i]) ([3]): …
3	PROPULSION ENERGY CONVERTER ([k])
3.1.	Manufacturer of the propulsion energy converter(s): …
3.1.1.	Manufacturer's code (as marked on the propulsion energy converter or other means of identification): …
3.2.	Internal combustion engine

3.2.1.1. Working principle: positive ignition/compression ignition/dual fuel ([1])
Cycle: four stroke/two stroke/rotary ([1])

3.2.1.2. Number and arrangement of cylinders: …

3.2.1.2.1. Bore ([1]): … mm

3.2.1.2.2. Stroke ([1]): … mm

3.2.1.2.3. Firing order: …

3.2.1.3. Engine capacity ([m]): … cm^3

3.2.1.4. Volumetric compression ratio ([2]): …

3.2.1.5. Drawings of combustion chamber, piston crown and, in the case of positive ignition engines, piston rings: …

3.2.1.6. Normal engine idling speed ([2]): … min^{-1}

3.2.1.6.1. High engine idling speed ([2]): … min^{-1}

3.2.1.8. Rated engine power ([n]): … kW at … min^{-1} (manufacturer's declared value)

3.2.1.9. Maximum permitted engine speed as prescribed by the manufacturer: … min^{-1}

3.2.1.10. Maximum net torque ([n]): … Nm at … min^{-1} (manufacturer's declared value)

3.2.1.11. The correction factor for compensating ambient conditions is set to 1, in accordance with paragraph 5.4.3 of Annex 5 to UN Regulation No 85: yes/no ([1]).

3.2.2. Fuel

3.2.2.1. Diesel/Petrol/LPG/NG or Biomethane/Ethanol (E 85)/Biodiesel/Hydrogen ([1]), ([6])

3.2.2.1.1. RON, unleaded: …

3.2.2.4. Vehicle fuel type: Mono fuel, Bi fuel, Flex fuel ([1])

3.2.2.5. Maximum amount of biofuel acceptable in fuel (manufacturer's declared value): … % by volume

3.2.4. Fuel feed

3.2.4.1. By carburettor(s): yes/no ([1])

3.2.4.2. By fuel injection (compression ignition or dual fuel only): yes/no ([1])

3.2.4.2.1. System description (common rail/unit injectors/distribution pump etc.): …

3.2.4.2.2. Working principle: direct injection/pre-chamber/swirl chamber ([1])

3.2.4.2.3. Injection/Delivery pump

3.2.4.2.3.1. Make(s): …

3.2.4.2.3.2. Type(s): …

3.2.4.2.3.3. Maximum fuel delivery ([1]) ([2]): … mm^3 /stroke or cycle at an engine speed of: … min^{-1} or, alternatively, a characteristic diagram: … (When boost control is supplied, state the characteristic fuel delivery and boost pressure versus engine speed)

3.2.4.2.4. Engine speed limitation control

3.2.4.2.4.2.1. Speed at which cut-off starts under load: … min^{-1}

3.2.4.2.4.2.2. Maximum no-load speed: … min^{-1}

3.2.4.2.6. Injector(s)

3.2.4.2.6.1. Make(s): …

3.2.4.2.6.2. Type(s): …

3.2.4.2.8. Auxiliary starting aid

3.2.4.2.8.1. Make(s): …

3.2.4.2.8.2. Type(s): …

3.2.4.2.8.3. System description: …

3.2.4.2.9. Electronic controlled injection: yes/no ([1])

3.2.4.2.9.1. Make(s): …

3.2.4.2.9.2. Type(s):

3.2.4.2.9.3 Description of the system: …

3.2.4.2.9.3.1. Make and type of the control unit (ECU): …

3.2.4.2.9.3.1.1. Software version of the ECU: …

3.2.4.2.9.3.2. Make and type of the fuel regulator: …

3.2.4.2.9.3.3. Make and type of the air-flow sensor: …

3.2.4.2.9.3.4. Make and type of fuel distributor: …

3.2.4.2.9.3.5. Make and type of the throttle housing: …

3.2.4.2.9.3.6. Make and type or working principle of water temperature sensor: …

3.2.4.2.9.3.7. Make and type or working principle of air temperature sensor: …

3.2.4.2.9.3.8. Make and type or working principle of air pressure sensor: …

3.2.4.3. By fuel injection (positive ignition only): yes/no ([1])

3.2.4.3.1. Working principle: single-/multi-point/direct injection /other (specify) ([1]): …

3.2.4.3.2. Make(s): …

3.2.4.3.3. Type(s): …

3.2.4.3.4. System description (In the case of systems other than continuous injection give equivalent details): …

3.2.4.3.4.1. Make and type of the control unit (ECU): …

3.2.4.3.4.1.1. Software version of the ECU: …

3.2.4.3.4.3. Make and type or working principle of air-flow sensor: …

3.2.4.3.4.8. Make and type of throttle housing: …

3.2.4.3.4.9. Make and type or working principle of water temperature sensor: …

3.2.4.3.4.10. Make and type or working principle of air temperature sensor: …

3.2.4.3.4.11. Make and type or working principle of air pressure sensor: …

3.2.4.3.5. Injectors

3.2.4.3.5.1. Make: …

3.2.4.3.5.2. Type: …

3.2.4.3.7. Cold start system

3.2.4.3.7.1. Operating principle(s): …

3.2.4.3.7.2. Operating limits/settings ([1]) ([2]): …

3.2.4.4. Feed pump

3.2.4.4.1. Pressure ([2]): … kPa or characteristic diagram ([2]): …

3.2.4.4.2. Make(s): …

3.2.4.4.3. Type(s): …

3.2.5. Electrical system

3.2.5.1. Rated voltage: … V, positive/negative ground ([1])

3.2.5.2. Generator

3.2.5.2.1. Type: …

3.2.5.2.2. Nominal output: … VA

3.2.6. Ignition system (spark ignition engines only)

3.2.6.1. Make(s): …

3.2.6.2. Type(s): …

3.2.6.3. Working principle: …

3.2.6.6. Spark plugs

3.2.6.6.1. Make: …

3.2.6.6.2. Type: …

3.2.6.6.3. Gap setting: … mm

3.2.6.7. Ignition coil(s)

3.2.6.7.1. Make: …

3.2.6.7.2. Type: …

3.2.7. Cooling system: liquid/air ([1])

3.2.7.1. Nominal setting of the engine temperature control mechanism: …

3.2.7.2. Liquid

3.2.7.2.1. Nature of liquid: …

3.2.7.2.2. Circulating pump(s): yes/no ([1])

3.2.7.2.3. Characteristics: … or

3.2.7.2.3.1. Make(s): …

3.2.7.2.3.2. Type(s): …

3.2.7.2.4. Drive ratio(s): …

3.2.7.2.5. Description of the fan and its drive mechanism: …

3.2.7.3. Air

3.2.7.3.1. Fan: yes/no ([1])

3.2.7.3.2. Characteristics: … or

3.2.7.3.2.1. Make(s): …

3.2.7.3.2.2. Type(s): …

3.2.7.3.3. Drive ratio(s): …

3.2.8. Intake system

3.2.8.1. Pressure charger: yes/no ([1])

3.2.8.1.1. Make(s): …

3.2.8.1.2. Type(s): …

3.2.8.1.3. Description of the system (e.g. maximum charge pressure: … kPa; wastegate if applicable): …

3.2.8.2. Intercooler: yes/no ([1])

3.2.8.2.1. Type: air-air/air-water ([1])

3.2.8.3. Intake depression at rated engine speed and at 100 % load (compression ignition engines only)

3.2.8.4. Description and drawings of inlet pipes and their accessories (plenum chamber, heating device, additional air intakes, etc.): …

3.2.8.4.1. Intake manifold description (include drawings and/or photos): …

3.2.8.4.2. Air filter, drawings: … or

3.2.8.4.2.1. Make(s): …

3.2.8.4.2.2. Type(s): …

3.2.8.4.3. Intake silencer, drawings: … or

3.2.8.4.3.1. Make(s): …

3.2.8.4.3.2. Type(s): …

3.2.9. Exhaust system

3.2.9.1. Description and/or drawing of the exhaust manifold: …

3.2.9.2. Description and/or drawing of the exhaust system: …

3.2.9.3. Maximum allowable exhaust back pressure at rated engine speed and at 100 % load (compression ignition engines only): … kPa

3.2.10. Minimum cross-sectional areas of inlet and outlet ports: …

3.2.11. Valve timing or equivalent data

3.2.11.1. Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to dead centres. For variable timing system, minimum and maximum timing: …

3.2.11.2. Reference and/or setting ranges ([1]): …

3.2.12. Measures taken against air pollution

3.2.12.1. Device for recycling crankcase gases (description and drawings): …

3.2.12.2. Pollution control devices (if not covered by another heading)

3.2.12.2.1. Catalytic converter

3.2.12.2.1.1. Number of catalytic converters and elements (provide the information below for each separate unit): …

3.2.12.2.1.2. Dimensions, shape and volume of the catalytic converter(s): …

3.2.12.2.1.3. Type of catalytic action: …

3.2.12.2.1.4. Total charge of precious metals: …

3.2.12.2.1.5. Relative concentration: …

3.2.12.2.1.6. Substrate (structure and material): …

3.2.12.2.1.7. Cell density: …

3.2.12.2.1.8. Type of casing for the catalytic converter(s): …

3.2.12.2.1.9. Location of the catalytic converter(s) (place and reference distance in the exhaust line): …

3.2.12.2.1.10. Heat shield: yes/no ([1])

3.2.12.2.1.11. Normal operating temperature range: … °C

3.2.12.2.1.12. Make of catalytic converter: …

3.2.12.2.1.13. Identifying part number: …

3.2.12.2.2. Sensors

3.2.12.2.2.1. Oxygen and/or lambda sensor(s): yes/no ([1])

3.2.12.2.2.1.1. Make: …

3.2.12.2.2.1.2. Location: …

3.2.12.2.2.1.3. Control range: …

3.2.12.2.2.1.4. Type or working principle: …

3.2.12.2.2.1.5. Identifying part number: …

3.2.12.2.2.2. NO_x sensor: yes/no ([1])

3.2.12.2.2.2.1. Make: …

3.2.12.2.2.2.2. Type: …

3.2.12.2.2.2.3. Location

3.2.12.2.2.3. Particulate sensor: yes/no ([1])

3.2.12.2.2.3.1. Make: …

3.2.12.2.2.3.2. Type: …

3.2.12.2.2.3.3. Location: …

3.2.12.2.3. Air injection: yes/no ([1])

3.2.12.2.3.1. Type (pulse air, air pump, etc.): …

3.2.12.2.4. Exhaust gas recirculation (EGR): yes/no ([1])

3.2.12.2.4.1. Characteristics (make, type, flow, high pressure/low pressure/combined pressure, etc.): …

3.2.12.2.4.2. Water-cooled system (to be specified for each EGR system e.g. low pressure/high pressure/combined pressure: yes/no ([1])

3.2.12.2.5. Evaporative emissions control system (petrol and ethanol engines only): yes/no ([1])

3.2.12.2.5.1. Detailed description of the devices: …

3.2.12.2.5.2. Drawing of the evaporative control system: …

3.2.12.2.5.3. Drawing of the carbon canister: …

3.2.12.2.5.4. Mass of dry charcoal: … g

3.2.12.2.5.5. Schematic drawing of the fuel tank (petrol and ethanol engines only): …

3.2.12.2.5.5.1. Fuel tank system capacity, material and construction: …

3.2.12.2.5.5.2. Description of vapour hose material, fuel line material and connection technique of the fuel system: …

3.2.12.2.5.5.3. Sealed tank system: yes/no

3.2.12.2.5.5.4. Description of fuel tank relief valve setting (air ingestion and relief): …

3.2.12.2.5.5.5. Description of the purge control system: …

3.2.12.2.5.6. Description and schematic of the heat shield between tank and exhaust system: …

3.2.12.2.5.7. Permeability factor: …

3.2.12.2.6. Particulate trap (PT): yes/no ([1])

3.2.12.2.6.1. Dimensions, shape and capacity of the particulate trap: …

3.2.12.2.6.2. Design of the particulate trap: …

3.2.12.2.6.3. Location (reference distance in the exhaust line): …

3.2.12.2.6.4. Make of particulate trap: …

3.2.12.2.6.5. Identifying part number: …

3.2.12.2.7 On-board-diagnostic (OBD) system: yes/no ([1])

3.2.12.2.7.1. Written description and/or drawing of the MI: …

3.2.12.2.7.2. List and purpose of all components monitored by the OBD system: …

3.2.12.2.7.3. Written description (general working principles) for

3.2.12.2.7.3.1 Positive-ignition engines

3.2.12.2.7.3.1.1. Catalyst monitoring: …

3.2.12.2.7.3.1.2. Misfire detection: …

3.2.12.2.7.3.1.3. Oxygen sensor monitoring: …

3.2.12.2.7.3.1.4. Other components monitored by the OBD system: …

3.2.12.2.7.3.2. Compression-ignition engines

3.2.12.2.7.3.2.1. Catalyst monitoring: …

3.2.12.2.7.3.2.2. Particulate trap monitoring: …

3.2.12.2.7.3.2.3. Electronic fuelling system monitoring: …

3.2.12.2.7.3.2.5. Other components monitored by the OBD system: …

3.2.12.2.7.4. Criteria for MI activation (fixed number of driving cycles or statistical method): …

3.2.12.2.7.5. List of all OBD output codes and formats used (with explanation of each): …

3.2.12.2.7.6. The following additional information shall be provided by the vehicle manufacturer for the purposes of enabling the manufacture of OBD-compatible replacement or service parts and diagnostic tools and test equipment.

3.2.12.2.7.6.1. A description of the type and number of the preconditioning cycles or alternative preconditioning methods used for the original type approval of the vehicle and the reason for their usage.

3.2.12.2.7.6.2. A description of the type of the OBD demonstration cycle used for the original type-approval of the vehicle for the component monitored by the OBD system.

3.2.12.2.7.6.3. A comprehensive document describing all sensed components with the strategy for fault detection and MI activation (fixed number of driving cycles or statistical method), including a list of relevant secondary sensed parameters for each component monitored by the OBD system. A list of all OBD output codes and format used (with an explanation of each) associated with individual emission related power-train components and individual non-emission related components, where monitoring of the component is used to determine MI activation, including in particular a comprehensive explanation for the data given in service $05 Test ID $21 to FF and the data given in service $06.

In the case of vehicle types that use a communication link in accordance with ISO 15765-4 “Road vehicles, diagnostics on controller area network (CAN) — Part 4: requirements for emissions-related systems”, a comprehensive explanation for the data given in service $06 Test ID $00 to FF, for each OBD monitor ID supported, shall be provided.

3.2.12.2.7.6.4. The information required above may be defined by completing a table as described below.

3.2.12.2.7.6.4.1. Light-duty vehicles

Component	Fault code	Monitoring strategy	Fault detection criteria	MI activation criteria	Secondary parameters	Preconditioning	Demonstration test
Catalyst	P0420	Oxygen sensor 1 and sensor 2 signals	Difference between sensor 1 and sensor 2 signals-	3rd cycle	Engine speed load, A/F mode, catalyst temperature	Two Type 1 cycles	Type 1

3.2.12.2.8. Other system: …

3.2.12.2.8.2. Driver inducement system

3.2.12.2.8.2.3. Type of inducement system: no engine restart after countdown/no start after refuelling/fuel-lock-out/performance restriction

3.2.12.2.8.2.4. Description of the inducement system

3.2.12.2.8.2.5. Equivalent to the average driving range of the vehicle with a complete tank of fuel: … km

3.2.12.2.10. Periodically regenerating system: (provide the information below for each separate unit)

3.2.12.2.10.1. Method or system of regeneration, description and/or drawing: …

3.2.12.2.10.2. The number of Type 1 operating cycles, or equivalent engine test bench cycles, between two cycles where regenerative phases occur under the conditions equivalent to Type 1 test (Distance "D"): …

3.2.12.2.10.2.1. Applicable Type 1 cycle (indicate the applicable procedure: Annex XXI or UN/ECE Regulation 83): …

3.2.12.2.10.2.2. The number of complete applicable test cycles required for regeneration (distance "d")

3.2.12.2.10.3. Description of method employed to determine the number of cycles between two cycles where regenerative phases occur: …

3.2.12.2.10.4. Parameters to determine the level of loading required before regeneration occurs (i.e. temperature, pressure etc.): …

3.2.12.2.10.5. Description of method used to load system: …

3.2.12.2.11. Catalytic converter systems using consumable reagents (provide the information below for each separate unit) yes/no ([1])

3.2.12.2.11.1. Type and concentration of reagent needed: …

3.2.12.2.11.2. Normal operational temperature range of reagent: …

3.2.12.2.11.3. International standard: …

3.2.12.2.11.4. Frequency of reagent refill: continuous/maintenance (where appropriate):

3.2.12.2.11.5. Reagent indicator: (description and location) …

3.2.12.2.11.6. Reagent tank

3.2.12.2.11.6.1. Capacity: …

3.2.12.2.11.6.2. Heating system: yes/no

3.2.12.2.11.6.2.1. Description or drawing

3.2.12.2.11.7. Reagent control unit: yes/no ([1])

3.2.12.2.11.7.1. Make: …

3.2.12.2.11.7.2. Type: …

3.2.12.2.11.8. Reagent injector (make type and location): …

3.2.12.2.11.9. Reagent quality sensor (make, type and location): …

3.2.12.2.12. Water injection: yes/no ([1])

3.2.13. Smoke opacity

3.2.13.1. Location of the absorption coefficient symbol (compression ignition engines only): …

3.2.14. Details of any devices designed to influence fuel economy (if not covered by other items): …

3.2.15. LPG fuelling system: yes/no ([1])

3.2.15.1. Type-approval number according to Regulation (EC) No 661/2009 (r) or Regulation (EU) 2019/2144(s): …

3.2.15.2. Electronic engine management control unit for LPG fuelling

3.2.15.2.1. Make(s): …

3.2.15.2.2. Type(s): …

3.2.15.2.3. Emission-related adjustment possibilities: …

3.2.15.3. Further documentation

3.2.15.3.1. Description of the safeguarding of the catalyst at switch-over from petrol to LPG or back: …

3.2.15.3.2. System lay-out (electrical connections, vacuum connections compensation hoses, etc.): …

3.2.15.3.3. Drawing of the symbol: …

3.2.16. NG fuelling system: yes/no ([1])

3.2.16.1. Type-approval number according to Regulation (EC) No 661/2009 or Regulation (EU) 2019/2144: …

3.2.16.2. Electronic engine management control unit for NG fuelling

3.2.16.2.1. Make(s): …

3.2.16.2.2. Type(s): …

3.2.16.2.3. Emission-related adjustment possibilities: …

3.2.16.3. Further documentation

3.2.16.3.1. Description of the safeguarding of the catalyst at switch-over from petrol to NG or back: …

3.2.16.3.2. System lay-out (electrical connections, vacuum connections compensation hoses, etc.): …

3.2.16.3.3. Drawing of the symbol: …

3.2.18. Hydrogen fuelling system: yes/no ([1])

3.2.18.1. EC type-approval number in accordance with Regulation (EC) No 79/2009 or Regulation (EU) 2019/2144: …

3.2.18.2. Electronic engine management control unit for hydrogen fuelling

3.2.18.2.1. Make(s): …

3.2.18.2.2. Type(s): …

3.2.18.2.3. Emission-related adjustment possibilities: …

3.2.18.3. Further documentation

3.2.18.3.1. Description of the safeguarding of the catalyst at switch-over from petrol to hydrogen or back: …

3.2.18.3.2. System lay-out (electrical connections, vacuum connections compensation hoses, etc.): …

3.2.18.3.3. Drawing of the symbol: …

3.2.19. H_2NG fuelling system: yes/no ([1])

3.2.19.1. Percentage of hydrogen in the fuel (the maximum specified by the manufacturer): …

3.2.19.2. Number of the EU type-approval certificate issued in accordance with UN Regulation No 110: …

3.2.19.3 Electronic engine management control unit for H2NG fuelling

3.2.19.3.1. Make(s): …

3.2.19.3.2. Type(s): …

3.2.19.3.3. Emission-related adjustment possibilities: …

3.2.19.4. Further documentation

3.2.19.4.2. System lay-out (electrical connections, vacuum connections compensation hoses, etc.): …

3.2.19.4.3. Drawing of the symbol: …

3.2.20. Heat storage information

3.2.20.1. Active heat storage device: yes/no ([1])

3.2.20.1.1. Enthalpy: … (J)

3.2.20.2. Insulation materials: yes/no ([1])

3.2.20.2.1. Insulation material: …

3.2.20.2.2. Insulation nominal volume: …([l])

3.2.20.2.3. Insulation nominal weight: …([t])

3.2.20.2.4. Insulation location: …

3.2.20.2.5. Worst case approach vehicle cool down: yes/no ([1])

3.2.20.2.5.1. (not worst case approach) Minimum soaking time, t_{soak_ATCT} (hours):…

3.2.20.2.5.2. (not worst case approach) Location of the engine temperature measurement: …

3.2.20.2.6. Single interpolation family within the ATCT family approach: yes/no ([1])

3.2.20.2.7. Worst case approach with regards to insulation: yes/no ([1])

3.2.20.2.7.1. Description of the ATCT measured reference vehicle regarding insulation: …

3.3. Electric powertrain (for PEV only)

3.3.1. General description of electric power train

3.3.1.1. Make: …

3.3.1.2. Type: …

3.3.1.3. Use ([1]): Monomotor/multimotors (number): …

3.3.1.4. Transmission arrangement: parallel/transaxial/others, to precise: …

3.3.1.5. Test voltage: … V

3.3.1.6. Motor nominal speed: … min^{-1}

3.3.1.7. Motor maximum speed: … min^{-1} or by default: reducer outlet shaft/gear box speed (specify gear engaged): … min^{-1}

3.3.1.9. Maximum power: … kW

3.3.1.10. Maximum thirty minutes power: … kW

3.3.1.11. Flexible range (where P > 90 per cent of max. power):
speed at the beginning of range: … min^{-1}
speed at the end of range: … min^{-1}

3.3.2. Traction REESS

3.3.2.1. Trade name and mark of the REESS: …

3.3.2.2. Kind of electro-chemical couple: …

3.3.2.3. Nominal voltage: … V

3.3.2.4. REESS maximum thirty minutes power (constant power discharge): … kW

3.3.2.5. REESS performance in 2 h discharge (constant power or constant current) ([1]):

3.3.2.5.1. REESS energy: … kWh

3.3.2.5.2. REESS capacity: … Ah in 2 h

3.3.2.5.3. End of discharge voltage value: … V

3.3.2.6. Indication of the end of the discharge that leads to a compulsory stop of the vehicle ([1]): ……..

3.3.2.7. REESS mass: …….. kg

3.3.2.8. Number of cells:……

3.3.2.9. REESS position:……

3.3.2.10. Type of coolant: air/liquid ([1])

3.3.2.11. Battery management system control unit

3.3.2.11.1. Make: ……..

3.3.2.11.2. Type: …….

3.3.2.11.3. Identification number: …..

3.3.3. Electric Motor

3.3.3.1. Working principle:

3.3.3.1.1. direct current/alternating current ([1]) /number of phases: ……..

3.3.3.1.2. separate excitation/series/compound ([1])

3.3.3.1.3. synchronous/asynchronous ([1])

3.3.3.1.4. coiled rotor/with permanent magnets/with housing ([1])

3.3.3.1.5. number of poles of the motor: ……..

3.3.3.2. Inertia mass: ……..

3.3.4. Power controller

3.3.4.1. Make: ……..

3.3.4.2. Type: ……..

3.3.4.2.1. Identification number: …..

3.3.4.3. Control principle: vectorial/open loop/closed/other (to be specified): ([1]) ……..

3.3.4.4. Maximum effective current supplied to the motor: ([2]) ……..
A during …….. seconds

3.3.4.5. Voltage range use: …….. V to …….. V

3.3.5. Cooling system:
Motor: liquid/air ([1])
Controller: liquid/air ([1])

3.3.5.1. Liquid-cooling equipment characteristics:

3.3.5.1.1. Nature of the liquid …….. circulating pumps: yes/no ([1])

3.3.5.1.2. Characteristics or make(s) and type(s) of the pump: ……..

3.3.5.1.3. Thermostat: setting: ……..

3.3.5.1.4. Radiator: drawing(s) or make(s) and type(s): ……..

3.3.5.1.5. Relief valve: pressure setting: ……..

3.3.5.1.6. Fan: characteristics or make(s) and type(s): ……..

3.3.5.1.7. Fan duct: ……..

3.3.5.2. Air-cooling equipment characteristics

3.3.5.2.1. Blower: characteristics or make(s) and type(s): ……..

3.3.5.2.2. Standard air ducting: ……..

3.3.5.2.3. Temperature regulating system: yes/no ([1])

3.3.5.2.4. Brief description: ……..

3.3.5.2.5. Air filter: …….. make(s): …….. type(s):

3.3.5.3. Temperatures admitted by the manufacturer (maximum)

3.3.5.3.1. Motor outlet: ……..°C

3.3.5.3.2. controller inlet: ……..°C

3.3.5.3.3. at motor reference point(s): ……..°C

3.3.5.3.4. at controller reference point(s): ……..°C

3.3.6. Insulating category: ……..

3.3.7. International protection (IP)-code: ……..

3.3.8. Lubrication system principle ([1]):
Bearings: friction/ball
Lubricant: grease/oil
Seal: yes/no
Circulation: with/without

3.3.9. Charger

3.3.9.1. Charger: on board/external ([1]) in case of an external unit, define the charger (trademark, model): ……..

3.3.9.2. Description of the normal profile of charge:

3.3.9.3. Specification of mains:

3.3.9.3.1. Type of mains: single phase/three phase ([1])

3.3.9.3.2. Voltage: ……..

3.3.9.4. Rest period recommended between the end of the discharge and the start of the charge: ……..

3.3.9.5. Theoretical duration of a complete charge: ……..

3.3.10. Electric energy converters

3.3.10.1. Electric energy converter between the electric machine and traction REESS

3.3.10.1.1. Make: ……..

3.3.10.1.2. Type: ……..

3.3.10.1.3. Declared nominal power: …….. W

3.3.10.2. Electric energy converter between the traction REESS and low voltage power supply

3.3.10.2.1. Make: ……..

3.3.10.2.2. Type: ……..

3.3.10.2.3. Declared nominal power: …….. W

3.3.10.3. Electric energy converter between the recharge-plug-in and traction REESS

3.3.10.3.1. Make: ……..

3.3.10.3.2. Type: ……..

3.3.10.3.3. Declared nominal power: …….. W

3.4. Combinations of propulsion energy converters

3.4.1. Hybrid electric vehicle: yes/no ([1])

3.4.2. Category of hybrid electric vehicle: off-vehicle charging/not off-vehicle charging: ([1])

3.4.3. Operating mode switch: with/without ([1])

3.4.3.1. Selectable modes

3.4.3.1.1. Pure electric: yes/no ([1])

3.4.3.1.2. Pure fuel consuming: yes/no ([1])

3.4.3.1.3. Hybrid modes: yes/no ([1])
(if yes, short description): …

3.4.4. Description of the energy storage device: (REESS, capacitor, flywheel/generator)

3.4.4.1. Make(s): …

3.4.4.2. Type(s): …

3.4.4.3. Identification number: …

3.4.4.4. Kind of electrochemical couple: …

3.4.4.5. Energy: … (for REESS: voltage and capacity Ah in 2 h, for capacitor: J, …)

3.4.4.6. Charger: on board/external/without ([1])

3.4.4.7. Type of coolant: air/liquid ([1])

3.4.4.8. Battery management system control unit

3.4.4.8.1. Make: ……..

3.4.4.8.2. Type: …….

3.4.4.8.3. Identification number: …..

3.4.5. Electric machine (describe each type of electric machine separately)

3.4.5.1. Make: …

3.4.5.2. Type: …

3.4.5.3. Primary use: traction motor/generator ([1])

3.4.5.3.1. When used as traction motor: single-/multimotors (number) ([1]): …

3.4.5.4. Maximum power: … kW

3.4.5.5. Working principle

3.4.5.5.5.1 Direct current/alternating current/number of phases: …

3.4.5.5.2. Separate excitation/series/compound ([1])

3.4.5.5.3. Synchronous/asynchronous ([1])

3.4.6. Control unit

3.4.6.1. Make(s): …

3.4.6.2. Type(s): …

3.4.6.3. Identification number: …

3.4.7. Power controller

3.4.7.1. Make: …

3.4.7.2. Type: …

3.4.7.3. Identification number: …

3.4.9. Manufacturer's recommendation for preconditioning: …

3.4.10.	FCHV: yes/no ([1])
3.4.10.1.	Type of Fuel Cell
3.4.10.1.2.	Make: …
3.4.10.1.3.	Type: …
3.4.10.1.4.	Nominal Voltage (V): …
3.4.10.1.5.	Type of coolant: air/liquid ([1])
3.4.10.2.	System description (working principle of the fuel cell, drawing, etc.): …
3.4.11.	Electric energy converters
3.4.11.1.	Electric energy converter between the electric machine and traction REESS
3.4.11.1.1.	Make: ……..
3.4.11.1.2.	Type: ……..
3.4.11.1.3.	Declared nominal power: …….. W
3.4.11.2.	Electric energy converter between the traction REESS and low voltage power supply
3.4.11.2.1.	Make: ……..
3.4.11.2.2.	Type: ……..
3.4.11.2.3.	Declared nominal power: …….. W
3.4.11.3.	Electric energy converter between the recharge-plug-in and traction REESS
3.4.11.3.1.	Make: ……..
3.4.11.3.2.	Type: ……..
3.4.11.3.3.	Declared nominal power: …….. W
3.5.	Manufacturer's declared values for determination of CO_2 emissions/fuel consumption/electric consumption/electric range and details of eco-innovations (where applicable) ([o])
3.5.7.	Manufacturer's declared values

3.5.7.1. Test vehicle parameters

Vehicle	Vehicle Low (VL) if existing	Vehicle High (VH)	VM if existing	V representative (only for road load matrix family (*)	Default values
Vehicle bodywork type			—		
Road load method used (measurement or calculation by road load family)			—	—	
Road load information:					
Tyres make and type, if measurement			—		
Tyre dimensions (front/rear), if measurement			—		
Tyre rolling resistance (front/rear) (kg/t)			—		
Tyre pressure (front/rear) (kPa), if measurement			—		
Delta C_D × A of vehicle L compared to vehicle H (IP_H minus IP_L)	—		—	—	
Delta C_D × A compared to road load family vehicle L (IP_H/L minus RL_L), if calculation by road load family			—	—	
Vehicle test mass (kg)					
Mass in running order (kg)			—	—	—
Technically permissible maximum laden mass (kg)			—	—	—
Road load coefficients					
f_0 (N)					
f_1 (N/(km/h))					
f_2 (N/(km/h)^2)					
Frontal area m^2 (0.000 m^2)	—	—	—		
Cycle Energy Demand (J)					

(*) representative vehicle is tested for the road load matrix family

3.5.7.1.1. Fuel used for the Type 1 test and selected for the measurement of the net power in accordance with Annex XX to this Regulation (for LPG or NG vehicles only): …

3.5.7.2. Combined CO_2 emissions

3.5.7.2.1. CO_2 emission for pure ICE vehicles and NOVC-HEVs

3.5.7.2.1.0. Minimum and maximum CO_2 values within the interpolation family: … g/km

3.5.7.2.1.1. Vehicle high: … g/km

3.5.7.2.1.2. Vehicle low (if applicable): … g/km

3.5.7.2.1.3. Vehicle M (if applicable): … g/km

3.5.7.2.2 Charge-Sustaining CO_2 emission for OVC-HEVs

3.5.7.2.2.1. Charge-Sustaining CO_2 emission vehicle high: g/km

3.5.7.2.2.2. Charge-Sustaining CO_2 emission vehicle low (if applicable): g/km

3.5.7.2.2.3 Charge-Sustaining CO_2 emission vehicle M (if applicable): g/km

3.5.7.2.3. Charge-Depleting CO_2 emission and weighted CO_2 emission for OVC-HEVs

3.5.7.2.3.1. Charge-Depleting CO_2 emission of Vehicle high: … g/km

3.5.7.2.3.2. Charge-Depleting CO_2 emission of Vehicle low (if applicable): … g/km

3.5.7.2.3.3. Charge-Depleting CO_2 emission of Vehicle M (if applicable): … g/km

3.5.7.2.3.4. Minimum and maximum weighted CO_2 values within the OVC interpolation family : … g/km

3.5.7.3. Electric range for electrified vehicles

3.5.7.3.1. Pure Electric Range (PER) for PEVs

3.5.7.3.1.1. Vehicle high: … km

3.5.7.3.1.2. Vehicle low (if applicable): … km

3.5.7.3.2. All Electric Range AER for OVC-HEVs and OVC-FCHVs (as applicable)

3.5.7.3.2.1. Vehicle high: … km

3.5.7.3.2.2. Vehicle low (if applicable): … km

3.5.7.3.2.3. Vehicle M (if applicable): … km

3.5.7.4. Fuel consumption (FCCS) for FCHVs

3.5.7.4.1. Charge-Sustaining fuel consumption for NOVC-FCHVs and OVC-FCHVs (as applicable)

3.5.7.4.1.1. Vehicle high: … kg/100 km

3.5.7.4.1.2. Vehicle low (if applicable): … kg/100 km

3.5.7.4.1.3. Vehicle M (if applicable): … kg/100 km

3.5.7.4.2. Charge-Depleting fuel consumption for OVC-FCHVs (as applicable)

3.5.7.4.2.1. Vehicle high: … kg/100 km

3.5.7.4.2.2. Vehicle low (if applicable): … kg/100 km

3.5.7.5. Electric energy consumption for electrified vehicles

3.5.7.5.1. Combined electric energy consumption (ECWLTC) for Pure electric vehicles

3.5.7.5.1.1. Vehicle high: … Wh/km

3.5.7.5.1.2. Vehicle low (if applicable): … Wh/km

3.5.7.5.2. UF-weighted charge-depleting electric consumption ECAC,CD (combined)

3.5.7.5.2.1. Vehicle high: … Wh/km

3.5.7.5.2.2. Vehicle low (if applicable): … Wh/km

3.5.7.5.2.3. Vehicle M (if applicable): … Wh/km

3.5.8. Vehicle fitted with an eco-innovation within the meaning of Article 11 of Regulation (EU) No 2019/631 for M1 or N1 vehicles: yes/no ([1])

3.5.8.1. Type/Variant/Version of the baseline vehicle as referred to in Article 5 of Regulation (EU) No 725/2011 for M1 vehicles or Article 5 of Regulation (EU) No 427/2014 for N1 vehicles (if applicable): …

3.5.8.2. Existence of interactions between different eco-innovations: yes/no ([1])

3.5.8.3. Emissions data related to the use of eco-innovations (repeat the table for each reference fuel tested) (w1)

Decision approving the eco-innovation (w2)	Code of the eco-innovation (w3)	1. CO_2 emissions of the baseline vehicle (g/km)	2. CO_2 emissions of the eco-innovation vehicle (g/km)	3. CO_2 emissions of the baseline vehicle under type 1 test-cycle (w4)	4. CO_2 emissions of the eco-innovation vehicle under type 1 test-cycle	5. Usage factor (UF), i.e. temporal share of technology usage in normal operation conditions	CO_2 emissions savings ((1 – 2) – (3 – 4))*5
xxx/201x							
Total WLTP CO_2 emissions saving (g/km)(w5)							

3.6. Temperatures permitted by the manufacturer

3.6.1. Cooling system

3.6.1.1. Liquid cooling
Maximum temperature at outlet: … K

3.6.1.2. Air cooling

3.6.1.2.1. Reference point: …

3.6.1.2.2. Maximum temperature at reference point: … K

3.6.2. Maximum outlet temperature of the inlet intercooler: … K

3.6.3. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold or turbocharger: … K

3.6.4. Fuel temperature
Minimum: … K — maximum: … K
For diesel engines at injection pump inlet, for gas fuelled engines at pressure regulator final stage

3.6.5.	Lubricant temperature Minimum: … K — maximum: … K
3.8.	Lubrication system
3.8.1.	Description of the system
3.8.1.1.	Position of lubricant reservoir: …
3.8.1.2.	Feed system (by pump/injection into intake/mixing with fuel, etc.) ([1])
3.8.2.	Lubricating pump
3.8.2.1.	Make(s): …
3.8.2.2.	Type(s): …
3.8.3.	Mixture with fuel
3.8.3.1.	Percentage: …
3.8.4.	Oil cooler: yes/no ([1])
3.8.4.1.	Drawing(s): … or
3.8.4.1.1.	Make(s): …
3.8.4.1.2.	Type(s): …
3.8.5.	Lubricant specification: …W…
4	TRANSMISSION (p)
4.3.	Moment of inertia of engine flywheel: …
4.3.1.	Additional moment of inertia with no gear engaged: …
4.4.	Clutch(es)
4.4.1.	Type: …
4.4.2.	Maximum torque conversion: …
4.5.	Gearbox
4.5.1.	Type (manual/automatic/CVT (continuously variable transmission)) ([1])
4.5.1.4.	Torque rating: …
4.5.1.5.	Number of clutches: …

4.6. Gear ratios

Gear	Internal gearbox ratios (ratios of engine to gearbox output shaft revolutions)	Final drive ratio(s) (ratio of gearbox output shaft to driven wheel revolutions)	Total gear ratios
Maximum for CVT			
1			
2			
3			
…			
Minimum for CVT			

4.6.1 Gearshift (not applicable in case of automatic transmission)

4.6.1.1. Gear 1 excluded: yes/no ([1])

4.6.1.2. $n_{\_95\_high}$ for each gear: … min^{-1}

4.6.1.3. n_{min_drive}

4.6.1.3.1. 1st gear: … min^{-1}

4.6.1.3.2. 1st gear to 2nd: … min^{-1}

4.6.1.3.3. 2nd gear to standstill: … min^{-1}

4.6.1.3.4. 2nd gear: … min^{-1}

4.6.1.3.5. 3rd gear and beyond: … min^{-1}

4.6.1.4. $n_{\_min\_drive\_set}$ for acceleration/constant speed phases ($n_{\_min\_drive\_up}$): … min^{-1}

4.6.1.5. $n_{\_min\_drive\_set}$ for deceleration phases ($n_{min\_drive\_down}$):

4.6.1.6. initial period of time

4.6.1.6.1.	$t_{\_start\_phase}$: … s
4.6.1.6.2.	$n_{\_min\_drive\_start}$: … min^{-1}
4.6.1.6.3.	$n_{\_min\_drive\_up\_start}$: … min^{-1}
4.6.1.7.	use of ASM: yes/no ([1])
4.6.1.7.1.	ASM values: … at … min^{-1}
4.7.	Maximum vehicle design speed (in km/h) (q): …
4.12.	Gearbox lubricant: …W…
6	SUSPENSION
6.6.	Tyres and wheels
6.6.1.	Tyre/wheel combination(s)
6.6.1.1.	Axles
6.6.1.1.1.	Axle 1: …
6.6.1.1.1.1.	Tyre size designation
6.6.1.1.2.	Axle 2: …
6.6.1.1.2.1.	Tyre size designation etc.
6.6.2.	Upper and lower limits of rolling radii
6.6.2.1.	Axle 1: …
6.6.2.2.	Axle 2: …
6.6.3.	Tyre pressure(s) as recommended by the vehicle manufacturer: … kPa
9	BODYWORK
9.1.	Type of bodywork using the codes defined in Part C of Annex I of Regulation (EU) 2018/858: …

12.	MISCELLANEOUS
12.10.	Devices or systems with driver selectable modes which influence CO_2 emissions, fuel consumption, electric energy consumption and/or criteria emissions and do not have a predominant mode: yes/no ([1])
12.10.1.	Charge-sustaining test (if applicable) (state for each device or system)
12.10.1.0.	Predominant mode under CS condition: yes/no ([1])
12.10.1.0.1.	Predominant mode under CS condition: … (if applicable)
12.10.1.1.	Best case mode: … (if applicable)
12.10.1.2.	Worst case mode: … (if applicable)
12.10.1.3.	Mode which enables the vehicle to follow the reference test cycle: … (in case no predominant mode under CS condition and only one mode is able to follow the reference test cycle)
12.10.2.	Charge-depleting test (if applicable) (state for each device or system)
12.10.2.0.	Predominant mode under CD condition: yes/no ([1])
12.10.2.0.1.	Predominant mode under CD condition: … (if applicable)
12.10.2.1.	Most energy consuming mode: … (if applicable)
12.10.2.2.	Mode which enables the vehicle to follow the reference test cycle: … (in case no predominant mode under CD condition and only one mode is able to follow the reference test cycle)
12.10.3.	Type 1 test (if applicable) (state for each device or system)
12.10.3.1.	Best case mode: …
12.10.3.2.	Worst case mode: …

Explanatory notes

([1]) Delete where not applicable (there are cases where nothing needs to be deleted when more than one entry is applicable).

([2]) Specify the tolerance.

([3]) Please fill in here the upper and lower values for each variant.

([6]) —

([7]) Optional equipment that affects the dimensions of the vehicle shall be specified.

([c]) Classified according to the definitions set out in Article 4 of Regulation (EU) 2018/858.

([f]) Where there is one version with a normal cab and another with a sleeper cab, both sets of masses and dimensions are to be stated.

([g]) Standard ISO 612: 1978 — Road vehicles — Dimensions of motor vehicles and towed vehicles — terms and definitions.

([h]) The mass of the driver is assessed at 75 kg.

The liquid containing systems (except those for used water that must remain empty) are filled to 100 % of the capacity specified by the manufacturer.

The information referred to in points 2.6(b) and 2.6.1(b) do not need to be provided for vehicle categories N2, N3, M2, M3, O3, and O4.

([i]) For trailers or semi-trailers, and for vehicles coupled with a trailer or a semi-trailer, which exert a significant vertical load on the coupling device or the fifth wheel, this load, divided by standard acceleration of gravity, is included in the maximum technically permissible mass.

([k]) In the case of a vehicle that can run either on petrol, diesel, etc., or also in combination with another fuel, items shall be repeated.

In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

([l]) This figure shall be rounded off to the nearest tenth of a millimetre.

([m]) This value shall be calculated (π = 3,1416) and rounded off to the nearest cm^3.

([n]) Determined in accordance with the requirements of Regulation (EC) No 715/2007 or Regulation (EC) No 595/2009 as applicable.

([o]) Determined in accordance with the requirements of Council Directive 80/1268/EEC (OJ L 375, 31.12.1980, p. 36).

([p]) The specified particulars are to be given for any proposed variants.

([q]) With respect to trailers, maximum speed permitted by the manufacturer.

([r]) OJ L 200, 31.7.2009, p. 1.

([s]) OJ L 325, 16.12.2019, p. 1.

([t]) For insulation nominal volume and insulation nominal weight, state to 2 decimal places. A tolerance of +/– 10 per cent shall be applied for insulation volume and insulation weight. Not to be documented if 'no' in paragraph 3.2.20.2.5. or 3.2.20.2.7.

([w]) Eco-innovations.

([w1]) Expand the table if necessary, using one extra row per eco-innovation.

([w2]) Number of the Commission Decision approving the eco-innovation.

([w3]) Assigned in the Commission Decision approving the eco-innovation.

([w4]) Under agreement of the type-approval authority, if a modelling methodology is applied instead of the type 1 test cycle, this value shall be the one provided by the modelling methodology.

([w5]) Sum of the CO_2 emissions savings of each individual eco-innovation.

Appendix 3a

DOCUMENTATION PACKAGES

Formal Documentation Package

The manufacturer may use one formal documentation package for multiple emission type approvals. The formal documentation package shall include the following information:

Point	Explanation
1. Emission Type Approval Number(s)	List of emission type approval number(s) covered by this BES-AES declaration: including TA reference, software reference, calibration number, checksums of each version and of each relevant Control Unit (CU) such as engine and aftertreatment ones
Method of reading of software and calibration version	E.g. scan-tool explanation
2. Base Emission Strategies	
BES x	Description of strategy x
BES y	Description of strategy y
3. Auxiliary Emission Strategies	
Presentation of the AESs	Hierarchical relations among AES: which AES takes precedence if more than one are present
AES x	— AES description and justification — Measured and/or modelled parameters for AES activation — Other parameters used to activate the AES — Increase of pollutants and CO_2 during the use of AES compared to BES
AES y	As above

Extended Documentation Package

The extended documentation package shall include the following information on all AES:

(a) a declaration of the manufacturer that the vehicle does not contain any defeat device not covered by one of the exceptions in Article 5(2) of Regulation (EC) No 715/2007;

(b) a description of the engine and the emission control strategies and devices employed, whether software or hardware, and any condition(s) under which the strategies and devices will not operate as they do during testing for TA;

(c) a declaration of the software versions used to control these AES/BES, including the appropriate checksums or reference values of these software versions and instructions to the authority on how to read the checksums or reference values; the declaration shall be updated and sent to the type approval authority that holds this extended documentation package each time there is a new software version that has an impact to the AES/BES. Manufacturers may request to use an alternative to a checksum as long as it provides an equivalent level of traceability for software version changes;

(d) detailed technical reasoning of any AES estimating the impact with the AES and without it, and information on the following:

(i) why any of the exception clauses from the defeat device prohibition in Article 5(2) of Regulation (EC) No 715/2007 apply;

(ii) hardware element(s) that need to be protected by the AES, where applicable;

(iii) proof of sudden and irreparable engine damage that cannot be prevented by regular maintenance and would occur in the absence of the AES, where applicable;

(iv) a reasoned explanation on why there is a need to use an AES upon engine start, where applicable;

(e) a description of the fuel system control logic, timing strategies and switch points during all modes of operation;

(f) a description of the hierarchical relations among the AES (i.e., when more than one AES can be active concurrently, an indication of which AES is primary in responding, the method by which strategies interact, including data flow diagrams and decision logic and how does the hierarchy assure emissions from all AES are controlled to the lowest practical level;

(g) a list of parameters which are measured and/or calculated by the AES, along with the purpose of every parameter measured and/or calculated and how each of those parameters relates to engine damage; including the method of calculation and how well these calculated parameters correlate with the true state of the parameter being controlled and any resulting tolerance or factor of safety incorporated into the analysis;

(h) a list of engine/emission control parameters which are modulated as a function of the measured or calculated parameter(s) and the range of modulation for each engine/emission control parameter; along with the relationship between engine/emission control parameters and measured or calculated parameters;

(i) an evaluation of how the AES will control real-driving emissions to the lowest practical level, including a detailed analysis of the expected increase of total regulated pollutants and CO_2 emissions by using the AES, compared to the BES.

The extended documentation package shall be limited to 100 pages and shall include all the main elements to allow the type approval authority to assess the AES. The package may be complemented with annexes and other attached documents, containing additional and complementary elements, if necessary. The manufacturer shall send a new version of the extended documentation package to the type approval authority every time changes are introduced to the AES. The new version shall be limited to the changes and their effect. The new version of the AES shall be evaluated and approved by the type approval authority.

The extended documentation package shall be structured as follows:

Extended Documentation Package for AES Application No YYY/OEM in accordance with Regulation (EU) 2017/1151

Parts	Paragraph	Point	Explanation
Introduction documents		Introduction letter to TAA	Reference of the document with the version, the date of issuing the document, signature by the relevant person in the manufacturer organisation
		Versioning table	Content of each version modifications: and with part is modified
		Description of the (emission) types concerned	
		Attached documents table	List of all attached documents
		Cross references	link to paragraph (a) to (i) of Appendix 3a (where to find each requirement of the regulation)
		Absence of defeat device declaration	+ signature

Parts	Paragraph	Point	Explanation
Core document	0	Acronyms/abbreviations	
	1	GENERAL DESCRIPTION	
	1.1	Engine general presentation	Description of main characteristics: displacement, after treatment,…
	1.2	General system architecture	System bloc diagram: list of sensors and actuators, explanation of engine general functions
	1.3	Reading of software and calibration version	E.g. scan-tool explanation
	2	Base Emission Strategies	
	2.x	BES x	Description of strategy x
	2.y	BES y	Description of strategy y
	3	Auxiliary Emission Strategies	
	3.0	Presentation of the AESs	Hierarchical relations among AES: description and justification (e.g. safety, reliability, etc.)
	3.x	AES x	3.x.1 AES justification 3.x.2 measured and/or modelled parameters for AES characterization 3.x.3 Action mode of AES - Parameters used 3.x.4 Effect of AES on pollutants and CO_2
	3.y	AES y	3.y.1 3.y.2 etc.
	100 page limit ends here		
	Annex		List of types covered by this BES-AES: including TA reference, software reference, calibration number, checksums of each version and of each CU (engine and/or after-treatment if any)
Attached documents		Technical note for AES justification n° xxx	Risk assessment or justification by testing or example of sudden damage, if any
		Technical note for AES justification n° yyy	
		Test report for specific AES impact quantification	test report of all specific tests done for AES justification, test conditions details, description of the vehicle, date of the tests, emission and/or CO_2 impact with or without AES activation'

(5) In Appendix 4 the Model of EC Type-Approval Certificate without the addendum, is replaced by the following:

'MODEL OF EC TYPE-APPROVAL CERTIFICATE

(Maximum format: A4 (210 × 297 mm))

EC TYPE-APPROVAL CERTIFICATE

Stamp of administration

Communication concerning the:

— EC type-approval ([1]),

— extension of EC type-approval ([1]),

— refusal of EC type-approval ([1]),

— withdrawal of EC type-approval ([1]),

— of a type of system/type of a vehicle with regard to a system ([1]) with regard to Regulation (EC) No 715/2007 ([2]) and Regulation (EU) 2017/1151 ([3])

EC type-approval number: …

Reason for extension: …

SECTION I

0.1. Make (trade name of manufacturer): …

0.2. Type: …

0.2.1. Commercial name(s) (if available): …

0.3. Means of identification of type if marked on the vehicle ([4])

0.3.1. Location of that marking: …

0.4. Category of vehicle ([5])

0.4.2. Base vehicle ([5a]) ([1]): yes/no ([1])

0.5. Name and address of manufacturer: …

0.8. Name(s) and address(es) of assembly plant(s): …

0.9. If applicable, name and address of manufacturer's representative: …

SECTION II

0. Interpolation family identifier as defined in paragraph 6.2.6. of UN Regulation No 154

1. Additional information (where applicable): (see addendum)

2. Technical service responsible for carrying out the tests: …

3. Date of type 1 test report: …

4. Number of the type 1 test report: …

5. Remarks (if any): (see Section 3 of addendum)

6. Place: …

7. Date: …

8. Signature: …

Attachments:	Information package ([6]) Test report(s)'

(6) Appendix 5 is deleted;

(7) Appendix 6 is amended as follows:

(1) In point 1. Table 1 is amended as follows:

(1) the rows AP to AR are replaced by the following:

"AP	Euro 6d-ISC-FCM	Euro 6-2	M, N1 class I	PI, CI	1.1.2020	1.1.2021	31.8.2024
AQ	Euro 6d-ISC-FCM	Euro 6-2	N1 class II	PI, CI	1.1.2021	1.1.2022	31.8.2024
AR	Euro 6d-ISC-FCM	Euro 6-2	N1 class III, N2	PI, CI	1.1.2021	1.1.2022	31.8.2024"

(2) after row AR the following rows are inserted:

'EA	Euro 6e	Euro 6-2	M, N1, N2	PI, CI	1.9.2023	1.9.2024	31.12.2025
EB	Euro 6e -bis	Euro 6-2	M, N1, N2	PI, CI	1.1.2025	1.1.2026	31.12.2027
EC	Euro 6e-bis-FCM	Euro 6-2	M, N1, N2	PI, CI	1.1.2027	1.1.2028'	

(2) after Table 1, the following text is added after the "key" regarding Euro 6d-ISC-FCM' RDE:

" 'Euro 6e'	=	As above + RDE compliance considering updated PEMS margins, OBFCM for N2 vehicles;
'Euro 6e-bis'	=	As above + increased extended ambient conditions for RDE compliance + AES Flag + utility factor based on d_{neb} (see point 3.2 of Annex XXI)
'Euro 6e-bis-FCM'	=	As above + utility factor based on d_{nec} (see point 3.2. of Annex XXI) ([1])

([1]) In case the value of d_{nec} changes following the review of 2024, a different character will be assigned to the vehicles types approved with the revised d_{nec}."

(3) point 2. is replaced by the following:

'2. EXAMPLES OF TYPE–APPROVAL CERTIFICATE NUMBERS

2.1 An example is provided below of a type-approval of a Euro 6 light passenger car to the "Euro 6d" emission standard and "Euro 6-2" OBD standard, identified by the characters "AJ" according to Table 1. The approval was granted for the base Regulation (EC) 715/2007 and its implementing Regulation (EU) 2017/1151. It is the 17th approval of this kind issued by Luxembourg, identified by the code "e13", without any extension. So the fourth and fifth sections of the approval number are "0017" and "00", respectively.

e13*715/2007*2017/1151AJ*0017*00

2.2 This second example shows a type-approval of a Euro 6 N1 class II light commercial vehicle to the "Euro 6d-TEMP" emission standard and "Euro 6-2" OBD standard, identified by the characters "AH" according to Table 1. The approval was granted for the base Regulation (EC) 715/2007 and its implementing legislation (as amended by Regulation (EU) 2018/1832). It is the 1st approval of this kind issued by Romania, identified by the code "e19", without any extension. So the fourth and fifth sections of the approval number are "0001" and "00", respectively.

e19*715/2007*2018/1832AH*0001*00

2.3 This third example shows a type-approval of a Euro 6 light passenger car to the "Euro 6e" emission standard and "Euro 6-2" OBD standard, identified by the characters "EA" according to Table 1. The approval was granted for the base Regulation (EC) 715/2007 and its implementing legislation (as amended by this Regulation (EU) 2023/443). It is a second extension to the 7th approval of this kind issued by the Netherlands, identified by the code "e4". So the fourth and fifth sections of the approval number are "00007" and "02", respectively.

e4*715/2007*2023/443EA*00007*02';

(8) Appendices 8a, 8b and 8c are replaced by the following:

'Appendix 8a

Test reports

A Test Report is the report issued by the technical service responsible for conducting the tests according this regulation.

PART I

The following information, if applicable, is the minimum data required for the Type 1 test.

Report number

APPLICANT			
Manufacturer			
SUBJECT	…		
Roadload family identifier(s)		:	

Interpolation family identifier(s)	:	

Object submitted to tests

	Make	:	
	IP identifier	:	
CONCLUSION	The object submitted to tests complies with the requirements mentioned in the subject.		

PLACE,	DD/MM/YYYY

General notes:

If there are several options (references), the one tested should be described in the test report

If there are not, a single reference to the information document at the start of the test report may be sufficient.

Every Technical Service is free to include some additional information

Characters are included in the sections of the test report relating to specific vehicle types, as follows:

"(a)" Specific to positive ignition engine vehicles.

"(b)" Specific to compression ignition engine vehicles.

1. DESCRIPTION OF TESTED VEHICLE(S): HIGH, LOW AND M (IF APPLICABLE)

1.1. *General*

Vehicle numbers	:	Prototype number and VIN
Category	:	
Bodywork	:	
Drive wheels	:	

1.1.1. *Powertrain Architecture*

Powertrain architecture	:	pure ICE, hybrid, electric or fuel cell

1.1.2. *INTERNAL COMBUSTION ENGINE (if applicable)*

For more than one ICE, please repeat the point

Make	:						
Type	:						

Working principle	:	two/four stroke					
Cylinders number and arrangement	:						
Engine capacity (cm^3)	:						
Engine idling speed (min^{-1})	:			+			
High engine idling speed (min^{-1}) (a)	:			+			
Rated engine power	:		kW		at		rpm
Maximum net torque	:		Nm		at		rpm
Engine lubricant	:	make and type					
Cooling system	:	Type: air/water/oil					
Insulation	:	material, amount, location, nominal volume and nominal weight (*)					

(*) a tolerance of +/– 10 per cent is permitted for volume and weight

1.1.3. *TEST FUEL for Type 1 test (if applicable)*

For more than one test fuel, please repeat the point

Make	:	
Type	:	Petrol E10 - Diesel B7 – LPG – NG - …
Density at 15 °C	:	
Sulphur content	:	Only for Diesel B7 and Petrol E10
Batch number	:	
Willans factors (for ICE) for CO_2 emission (gCO_2/MJ)	:	

1.1.4. *FUEL FEED SYSTEM (if applicable)*

For more than one fuel feed system, please repeat the point

Direct injection	:	yes/no or description
Vehicle fuel type	:	Monofuel / bifuel / flex fuel

Control unit	:	
Part reference	:	same as information document
Software tested	:	read via scantool, for example
Air flowmeter	:	
Throttle body	:	
Pressure sensor	:	
Injection pump	:	
Injector(s)	:	

1.1.5. *INTAKE SYSTEM (if applicable)*

For more than one intake system, please repeat the point

Pressure charger	:	Yes/no make & type (1)
Intercooler	:	yes/no type (air/air – air/water) (1)
Air filter (element) (1)	:	make & type
Intake silencer (1)	:	make & type

1.1.6. *EXHAUST SYSTEM AND ANTI-EVAPORATIVE SYSTEM (if applicable)*

For more than one, please repeat the point

First catalytic converter	:	make & reference (1) principle: three way / oxidising / NO_x trap / NO_x storage system / Selective Catalyst Reduction…
Second catalytic converter	:	make & reference (1) principle: three way/oxidising / NO_x trap / NO_x storage system / Selective Catalyst Reduction…
Particulate trap	:	with/without/not applicable catalysed: yes/no make & reference (1)
Reference and position of oxygen sensor(s)	:	before catalyst/after catalyst

Air injection	:	with/without/not applicable
Water injection	:	with/without/not applicable
EGR	:	with/without/not applicable cooled/non-cooled HP/LP
Evaporative emission control system	:	with/without/not applicable
Reference and position of NO_x sensor(s)	:	Before/after
General description (1)	:	

1.1.7. *HEAT STORAGE DEVICE (if applicable)*

For more than one Heat Storage System, please repeat the point

Heat storage device	:	yes/no
Heat capacity (enthalpy stored J)	:	
Time for heat release (s)	:	

1.1.8. *TRANSMISSION (if applicable)*

For more than one Transmission, please repeat the point

Gearbox	:	manual / automatic / continuous variation

Gear shifting procedure

Predominant mode ([1])	:	yes/no normal / drive / eco/…
Best case mode for CO_2 emissions and fuel consumption (if applicable)	:	
Worst case mode for CO_2 emissions and fuel consumption (if applicable)	:	
Highest electric energy consumption mode (if applicable)	:	
Control unit	:	
Gearbox lubricant	:	make and type

Tyres

Make	:	
Type	:	

Dimensions front/rear	:	
Dynamic circumference (m)	:	
Tyre pressure (kPa)	:	

([1]) For OVC-HEV, specify for charge-sustaining and for charge-depleting operating conditions.

Transmission ratios (R.T.), primary ratios (R.P.) and (vehicle speed (km/h)) / (engine speed (1 000 (min^{-1})) ($V_{1\ 000}$) for each of the gearbox ratios (R.B.).

R.B.	R.P.	R.T.	$V_{1\ 000}$
1st	1/1		
2nd	1/1		
3rd	1/1		
4th	1/1		
5th	1/1		
…			

1.1.9. *ELECTRIC MACHINE (if applicable)*

For more than one Electric Machine, please repeat the point

Make	:	
Type	:	
Peak Power (kW)	:	

1.1.10. *TRACTION REESS (if applicable)*

For more than one Traction REESS, please repeat the point

Make	:	
Type	:	
Capacity (Ah)	:	
Nominal Voltage (V)	:	

1.1.11. *FUEL CELL (if applicable)*

For more than one Fuel Cell, please repeat the point

Make	:	
Type	:	

Maximum Power (kW)	:	
Nominal Voltage (V)	:	

1.1.12. *POWER ELECTRONICS (if applicable)*

Can be more than one PE (propulsion converter, low voltage system or charger)

Make	:	
Type	:	
Power (kW)	:	

1.2. *Vehicle high description*

1.2.1. *MASS*

Test mass of VH (kg)	:	

1.2.2. *ROAD LOAD PARAMETERS*

f_0 (N)	:	
f_1 (N/(km/h))	:	
f_2 (N/(km/h)^2)	:	
Cycle energy demand (J)	:	
Road load test report reference	:	
Road load family's identifier	:	

1.2.3. *CYCLE SELECTION PARAMETERS*

Cycle (without downscaling)	:	Class 1 / 2 / 3a / 3b
Ratio of rated power to mass in running order (PMR)(W/kg)	:	(if applicable)
Capped speed process used during measurement	:	yes/no
Maximum speed of the vehicle (km/h)	:	
Downscaling (if applicable)	:	yes/no
Downscaling factor fdsc	:	
Cycle distance (m)	:	
Constant speed (in the case of the shortened test procedure)	:	if applicable

1.2.4. *GEAR SHIFT POINT (IF APPLICABLE)*

Version of Gear Shift calculation		(indicate the applicable amendment to Regulation (EU) 2017/1151)
Gear shifting	:	Average gear for v ≥ 1 km/h, x.xxxx
n_{min} drive		
1st gear	:	…min^{-1}
1st gear to 2nd	:	…min^{-1}
2nd gear to standstill	:	…min^{-1}
2nd gear	:	…min^{-1}
3rd gear and beyond	:	…min^{-1}
Gear 1 excluded	:	yes/no
n_95_high for each gear	:	…min^{-1}
n_min_drive_set for acceleration/constant speed phases (n_min_drive_up)	:	…min^{-1}
n_min_drive_set for deceleration phases (nmin_drive_down)	:	…min^{-1}
t_start_phase	:	…s
n_min_drive_start	:	…min^{-1}
n_min_drive_up_start	:	…min^{-1}
use of ASM	:	yes/no
ASM values	:	

1.3. *Vehicle low description (if applicable)*

1.3.1. *MASS*

Test mass of VL(kg)	:	

1.3.2. *ROAD LOAD PARAMETERS*

f_0 (N)	:	
f_1 (N/(km/h))	:	
f_2 $(N/(km/h)^2)$	:	
Cycle energy demand (J)	:	
$\Delta(C_D \times A_f)_{LH}$ (m^2)	:	

Road load test report reference	:	
Road load family's identifier	:	

1.3.3. *CYCLE SELECTION PARAMETERS*

Cycle (without downscaling)	:	Class 1 / 2 / 3a / 3b
Ratio of rated power to mass in running order – 75 kg (PMR)(W/kg)	:	(if applicable)
Capped speed process used during measurement	:	yes/no
Maximum speed of the vehicle	:	
Downscaling (if applicable)	:	yes/no
Downscaling factor fdsc	:	
Cycle distance (m)	:	
Constant speed (in the case of the shortened test procedure)	:	if applicable

1.3.4. *GEAR SHIFT POINT (IF APPLICABLE)*

Gear shifting	:	Average gear for v ≥ 1 km/h, x.xxxx

1.4. *Vehicle M description (if applicable)*

1.4.1. *MASS*

Test mass of VL(kg)	:	

1.4.2. *ROAD LOAD PARAMETERS*

f_0 (N)	:	
f_1 (N/(km/h))	:	
f_2 (N/(km/h)^2)	:	
Cycle energy demand (J)	:	
$\Delta(C_D \times A_f)_{LH}$ (m^2)	:	
Road load test report reference	:	
Road load family's identifier	:	

1.4.3. *CYCLE SELECTION PARAMETERS*

Cycle (without downscaling)	:	Class 1 / 2 / 3a / 3b
Ratio of rated power to mass in running order – 75 kg (PMR)(W/kg)	:	(if applicable)
Capped speed process used during measurement	:	yes/no
Maximum speed of the vehicle	:	
Downscaling (if applicable)	:	yes/no
Downscaling factor fdsc	:	
Cycle distance (m)	:	
Constant speed (in the case of the shortened test procedure)	:	if applicable

1.4.4. *GEAR SHIFT POINT (IF APPLICABLE)*

Gear shifting	:	Average gear for v ≥ 1 km/h, x,xxxx

2. *TEST RESULTS*

2.1. *Type 1 test*

Method of chassis dyno setting	:	Fixed run / iterative / alternative with its own warmup cycle
Dynamometer in 2WD/4WD operation	:	2WD/4WD
For 2WD operation, was the non-powered axle rotating	:	yes/no/not applicable
Dynamometer operation mode		yes/no
Coastdown mode	:	yes/no
Additional preconditioning	:	yes/no description
Deterioration factors	:	assigned / tested

2.1.1. *Vehicle high*

Date(s) of test(s)			:	(day/month/year)
Place of the test(s)	:	Chassis dyno, location, country		
Height of the lower edge above ground of cooling fan (cm)	:			

Lateral position of fan centre (if modified as request by the manufacturer)	:	in the vehicle centre-line/…		
Distance from the front of the vehicle (cm)	:			
IWR: Inertial Work Rating (%)	:	x,x		
RMSSE: Root Mean Squared Speed Error (km/h)	:	x,xx		
Description of the accepted deviation of the driving cycle	:	PEV before break off criteria or Fully operated acceleration pedal		

2.1.1.1. Pollutant emissions (if applicable)

2.1.1.1.1. Pollutant emissions of vehicles with at least one combustion engine, of NOVC-HEVs and of OVC-HEVs in case of a charge-sustaining Type 1 test

For each driver selectable mode tested the points below shall be repeated (predominant mode or best case mode and worst case mode, if applicable)

Test 1

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	Particulate Matter	Particle Number
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Measured values							
Regeneration factors (Ki)(2) Additive							
Regeneration factors (Ki)(2) Multiplicative							
Deterioration factors (DF) additive							
Deterioration factors (DF) multiplicative							
Final values							
Limit values							

(2) See Ki family report(s)	:	
Type 1/I performed for Ki determination	:	in accordance with Annex B4 to UN Regulation No 154 or UN/ECE Regulation No 83 ([1])
Regeneration family's identifier	:	

([1]) Indicate as applicable.

Test 2 if applicable: for CO_2 reason ($d_{CO_2}{}^1$) / for pollutants reason (90 % of the limits) / for both

Record test results in accordance with the table of Test 1

Test 3 if applicable: for CO_2 reason ($d_{CO_2}{}^2$)

Record test results in accordance with the table of Test 1

2.1.1.1.2. Pollutant emissions of OVC-HEVs in case of a charge-depleting Type 1 test

Test 1

Pollutant emission limits have to be fulfilled and the following point has to be repeated for each driven test cycle.

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	Particulate Matter	Particle Number
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Measured single cycle values							
Limit single cycle values							

Test 2 (if applicable): for CO_2 reason ($d_{CO_2}{}^1$) / for pollutants reason (90 % of the limits) / for both

Record test results in accordance with the table of Test 1

Test 3 (if applicable): for CO_2 reason ($d_{CO_2}{}^2$)

Record test results in accordance with the table of Test 1

2.1.1.1.3. UF-WEIGHTED POLLUTANT EMISSIONS OF OVC-HEVS

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	Particulate Matter	Particle Number
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Calculated values							

2.1.1.2. CO_2 emission *(if applicable)*

2.1.1.2.1. CO_2 emission of vehicles with at least one combustion engine, of NOVC-HEV and of OVC-HEV in the case of a charge-sustaining Type 1 test

For each driver selectable mode tested the points below have to be repeated (predominant mode or best case mode and worst case mode, if applicable)

Test 1

CO_2 emission	Low	Medium	High	Extra High	Combined
Measured value $M_{CO_2,p,1}$/ $M_{CO_2,c,2}$					
Speed and distance corrected value $M_{CO_2,p,2b}$ / $M_{CO_2,c,2b}$					
RCB correction coefficient: (5)					
$M_{CO_2,p,3}$ / $M_{CO_2,c,3}$					
Regeneration factors (Ki) Additive					
Regeneration factors (Ki) Multiplicative					
$M_{CO_2,c,4}$			—		
AF_{Ki} = $M_{CO_2,c,3}$ / $M_{CO_2,c,4}$			—		
$M_{CO_2,p,4}$ / $M_{CO_2,c,4}$					—
ATCT correction (FCF) (4)					
Temporary values $M_{CO_2,p,5}$ / $M_{CO_2,c,5}$					
Declared value	—	—	—	—	
d_{CO_2} [1] * *declared value*	—	—	—	—	

(4) FCF: family correction factor for correcting for representative regional temperature conditions (ATCT)

See ATCT family report(s)	:	
ATCT family's identifier	:	

(5) correction as referred to in Annex B6 - Appendix 2 of UN Regulation No 154 for pure ICE vehicles, and Annex B8 - Appendix 2 of UN Regulation No 154 for HEVs (K_{CO_2})

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion

CO_2 emission (g/km)	Low	Medium	High	Extra High	Combined
Averaging $M_{CO_2,p,6}$ / $M_{CO_2,c,6}$					
Alignment $M_{CO_2,p,7}$ / $M_{CO_2,c,7}$					
Final values $M_{CO_2,p,H}$ / $M_{CO_2,c,H}$					

Information for Conformity of Production for OVC-HEV

	Combined
CO_2 emission (g/km) $M_{CO_2,CS,COP}$	
$AF_{CO_2,CS}$	

2.1.1.2.2. CO_2 emission of OVC-HEVs in case of a charge-depleting Type 1 test

Test 1

CO_2 emission (g/km)	Combined
Calculated value $M_{CO_2,CD}$	
Declared value	
d_{CO_2} [1]	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion

CO_2 emission (g/km)	Combined
Averaging $M_{CO_2,CD}$	
Final value $M_{CO_2,CD}$	

2.1.1.2.3. UF-WEIGHTED CO_2 emission of OVC-HEVs

CO_2 emission (g/km)	Combined
Calculated value $M_{CO_2,weighted}$	

2.1.1.3. FUEL CONSUMPTION (IF APPLICABLE)

2.1.1.3.1. Fuel consumption of vehicles with only a combustion engine, of NOVC-HEVs and of OVC-HEVs in case of a charge-sustaining Type 1 test

For each driver selectable mode tested the points below has to be repeated (predominant mode or best case mode and worst case, mode if applicable)

Fuel consumption (l/100 km)	Low	Medium	High	Extra High	Combined
Final values $FC_{p,H}$ / $FC_{c,H}$ (1)					

(1) Calculated from aligned CO_2 values.

A- On-board Fuel and/or Energy Consumption Monitoring for vehicles referred to in Article 4a

a. Data accessibility

The parameters listed in point 3 of Annex XXII are accessible: yes/not applicable

b. Accuracy (if applicable)

$Fuel\_Consumed_{WLTP}$ (litres) (1)	Vehicle HIGH - Test 1	x,xxx
	Vehicle HIGH - Test 2 (if applicable)	x,xxx
	Vehicle HIGH - Test 3 (if applicable)	x,xxx
	Vehicle LOW - Test 1 (if applicable)	x,xxx
	Vehicle LOW Test 2 (if applicable)	x,xxx
	Vehicle LOW - Test 3 (if applicable)	x,xxx
	Total	x,xxx
$Fuel\_Consumed_{OBFCM}$ (litres) (2)	Vehicle HIGH - Test 1	x,xxx (*)
	Vehicle HIGH - Test 2 (if applicable)	x,xxx (*)
	Vehicle HIGH - Test 3 (if applicable)	x,xxx (*)
	Vehicle LOW - Test 1 (if applicable)	x,xxx (*)

	Vehicle LOW Test 2 (if applicable)	x,xxx (*)
	Vehicle LOW - Test 3 (if applicable)	x,xxx (*)
	Total	x,xxx (*)
Accuracy ([3])		x,xxx

(*) In the case that the OBFCM signal can only be read-out to 2 decimal places, the third decimal place shall be introduced as a zero.
([1]) In accordance with Annex XXII.
([2]) In accordance with Annex XXII.
([3]) In accordance with Annex XXII.

2.1.1.3.2. Fuel consumption of OVC-HEVs and OVC-FCHVs in case of a charge-depleting Type 1 test

Test 1

Fuel consumption (l/100 km or kg/100 km)	Combined
Calculated value FC_{CD}	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion

Fuel consumption (l/100km or kg/100 km)	Combined
Averaging FC_{CD}	
Final value FC_{CD}	

2.1.1.3.3. UF-Weighted Fuel consumption of OVC-HEVs and OVC-FCHVs

Fuel consumption (l/100 km or kg/100 km)	Combined
Calculated value $FC_{weighted}$	

2.1.1.3.4. Fuel consumption of vehicles of NOVC-FCHVs and OVC-FCHVs in case of a charge-sustaining Type 1 test

For each driver selectable mode tested the points below has to be repeated (predominant mode or best case mode and worst case, mode if applicable)

Fuel consumption (kg/100 km)	Combined
Measured values	
RCB correction coefficient	
Final values FC_c	

2.1.1.4. RANGES (IF APPLICABLE)

2.1.1.4.1. Ranges for OVC-HEVs and OVC-FCHVs (if applicable)

2.1.1.4.1.1. All electric range

Test 1

AER (km)	City	Combined
Measured/Calculated values AER		
Declared value	—	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion

AER (km)	City	Combined
Averaging AER (if applicable)		
Final values AER		

2.1.1.4.1.2. Equivalent All electric Range

EAER (km)	Low	Medium	High	Extra High	City	Combined
Final values EAER						

2.1.1.4.1.3. Actual Charge-Depleting Range

R_{CDA} (km)	Combined
Final value R_{CDA}	

2.1.1.4.1.4. Charge-Depleting Cycle Range

Test 1

R_{CDC} (km)	Combined
Final value R_{CDC}	
Index Number of the transition cycle	
REEC of confirmation-cycle (%)	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

2.1.1.4.2. Ranges for PEVs - Pure electric range (if applicable)

Test 1

PER (km)	Low	Medium	High	Extra High	City	Combined
Calculated values PER						
Declared value	—	—	—	—	—	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion

PER (km)	City	Combined
Averaging PER		
Final values PER		

2.1.1.5. *ELECTRIC CONSUMPTION (IF APPLICABLE)*

2.1.1.5.1. Electric consumption of OVC-HEVs and OVC-FCHVs (if applicable)

2.1.1.5.1.1. Recharged electric energy (E_{AC})

E_{AC} (Wh)	

2.1.1.5.1.2. Electric consumption (EC)

EC (Wh/km)	Low	Medium	High	Extra High	City	Combined
Final values EC						

2.1.1.5.1.3. UF-weighted charge-depleting electric consumption

Test 1

$EC_{AC,CD}$ (Wh/km)	Combined
Calculated value $EC_{AC,CD}$	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion (if applicable)

$EC_{AC,CD}$ (Wh/km)	Combined
Averaging $EC_{AC,CD}$	
Final value	

2.1.1.5.1.4. UF-weighted electric consumption

Test 1

$EC_{AC,weighted}$ (Wh)	Combined
Calculated value $EC_{AC,weighted}$	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

Conclusion (if applicable)

$EC_{AC,weighted}$ (Wh/km)	Combined
Averaging $EC_{AC,weighted}$	
Final value	

2.1.1.5.1.5. Information for COP

	Combined
Electric consumption (Wh/km) $EC_{DC,CD,COP}$	
$AF_{EC,AC,CD}$	

2.1.1.5.2. Electric consumption of PEVs (if applicable)

Test 1

EC (Wh/km)	City	Combined
Calculated values EC		
Declared value	—	

Test 2 (if applicable)

Record test results in accordance with the table of Test 1

Test 3 (if applicable)

Record test results in accordance with the table of Test 1

EC (Wh/km)	Low	Medium	High	Extra High	City	Combined
Averaging EC						
Final values EC						

Information for COP

	Combined
Electric Consumption (Wh/km) $EC_{DC,COP}$	
AF_{EC}	

2.1.2. *VEHICLE LOW (IF APPLICABLE)*

Repeat § 2.1.1.

2.1.3. *VEHICLE M (IF APPLICABLE)*

Repeat § 2.1.1.

2.1.4. *FINAL CRITERIA EMISSIONS VALUES (IF APPLICABLE)*

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	PM	PN
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Highest values (1)							

(1) Indicate for each pollutant the highest among the average test results of VH, VL (if applicable) and VM (if applicable).

2.2. *Type 2 (a) test*

Included the emissions data required for roadworthiness testing

Test	CO (% vol)	Lambda (1)	Engine speed (min^{-1})	Oil temperature (°C)
Idle		—		
High idle				

(1) Delete where not applicable (there are cases where nothing needs to be deleted when more than one entry is applicable).

2.3. *Type 3 (a) test*

Emission of crankcase gases into the atmosphere: none

2.4. *Type 4 (a) test*

Family's identifier	:	
See report(s)	:	

2.5. *Type 5 test*

Family's identifier	:	
See durability family report(s)	:	
Type 1/I cycle for criteria emissions testing	:	According to UN Regulation 154 Annex B4 or UN/ECE Regulation No 83 [1]

[1] Indicate as applicable.

2.6. *RDE test (type 1a)*

RDE family number	:	MSxxxx
See family report(s)	:	

2.7. *Type 6 test (a)*

Family's identifier		
Date of tests	:	(day/month/year)
Place of tests	:	
Method of setting of the chassis dyno	:	coast down (road load reference)
Inertia mass (kg)	:	
If deviation from the vehicle of Type 1 test	:	
Tyres	:	
Make	:	
Type	:	
Dimensions front/rear	:	
Dynamic circumference (m)	:	
Tyre pressure (kPa)	:	

Pollutants		CO (g/km)	HC (g/km)
Test	1		
	2		
	3		
Average			
Limit			

2.8. *On board diagnostic system*

Family's identifier	:	
See family report(s)	:	

2.9. *Smoke opacity test (b)*

2.9.1. *STEADY SPEEDS TEST*

See family report(s)	:	

2.9.2. *FREE ACCELERATION TEST*

Measured absorption value (m^{-1})	:	
Corrected absorption value (m^{-1})	:	

2.10. *Engine power*

See report(s) or approval number	:	

2.11. *Temperature information related to vehicle high (VH)*

Worst case approach with regards to vehicle insulation	:	yes/no [1]
Worst case approach vehicle cool down	:	yes/no[10]
ATCT family composed of a single Interpolation family	:	yes/no[10]
Engine coolant temperature at the end of soaking time (°C)	:	
Average soak area temperature over the 3 last hours (°C)	:	

Difference between engine coolant end temperature and average soak area temperature of the last 3 hours Δ_{T_ATCT} (°C)	:	
The minimum soaking time t_{soak_ATCT} (s)	:	
Location of temperature sensor	:	
Measured engine temperature	:	oil/coolant

([1]) If 'yes' then the six last lines are not applicable.

2.12. Exhaust after-treatment system using reagent

Family's identifier	:	
See family report(s)	:	

PART II

The following information, if applicable, is the minimum data required for the ATCT test.

Report number

APPLICANT				
Manufacturer				
SUBJECT	…			
Roadload family identifier(s)		:		
Interpolation family identifier(s)		:		
ATCT identifier(s)		:		

Object submitted to tests

	Make	:	
	IP identifier	:	
CONCLUSION	The object submitted to tests complies with the requirements mentioned in the subject.		

PLACE,	DD/MM/YYYY

General notes:

If there are several options (references), the one tested should be described in the test report

If there are not, a single reference to the information document at the start of the test report may be sufficient.

Every Technical Service is free to include some additional information

Characters are included in the sections of the test report relating to specific vehicle types, as follows:

"(a)" Specific to positive ignition engine vehicles.

"(b)" Specific to compression ignition engine vehicles.

1. *DESCRIPTION OF TESTED VEHICLE*

1.1. **GENERAL**

Vehicle numbers	:	Prototype number and VIN
Category	:	
Bodywork	:	
Drive wheels	:	

1.1.1. *Powertrain Architecture*

Powertrain architecture	:	pure ICE, hybrid, electric or fuel cell

1.1.2. *INTERNAL COMBUSTION ENGINE (if applicable)*

For more than one ICE, please repeat the point

Make	:						
Type	:						
Working principle	:	two/four stroke					
Cylinders number and arrangement	:	…					
Engine capacity (cm^3)	:						
Engine idling speed (min^{-1})	:			±			
High engine idling speed (min^{-1}) (a)	:			±			
Rated engine power	:		kW		at		rpm
Maximum net torque	:		Nm		at		rpm
Engine lubricant	:	make and type					
Cooling system	:	Type: air/water/oil					
Insulation	:	material, amount, location, nominal volume and nominal weight (*)					

(*) a tolerance of +/– 10 per cent is permitted for volume and weight

1.1.3. *TEST FUEL for type 1 test (if applicable)*

For more than one test fuel, please repeat the point

Make	:	
Type	:	Petrol E10 - Diesel B7 – LPG – NG - …
Density at 15 °C	:	
Sulphur content	:	Only for Diesel and Petrol
Annex IX	:	
Batch number	:	
Willans factors (for ICE) for CO_2 emission (gCO_2/MJ)	:	
Direct injection	:	yes/no or description
Vehicle fuel type	:	Monofuel / bifuel / flex fuel
Control unit		
Part reference	:	same as information document
Software tested	:	read via scantool, for example
Air flowmeter	:	
Throttle body	:	
Pressure sensor	:	
Injection pump	:	
Injector(s)	:	

1.1.4. *FUEL FEED SYSTEM (if applicable)*

For more than one fuel feed system, please repeat the point

1.1.5. *INTAKE SYSTEM (if applicable)*

For more than one intake system, please repeat the point

Pressure charger	:	Yes/no make & type (1)
Intercooler	:	yes/no type (air/air – air/water) (1)

Air filter (element) (1)	:	make & type
Intake silencer (1)	:	make & type

1.1.6. *EXHAUST SYSTEM AND ANTI-EVAPORATIVE SYSTEM (if applicable)*

For more than one, please repeat the point

First catalytic converter	:	make & reference (1) principle: three way / oxidising / NO_x trap / No_x storage system / Selective Catalyst Reduction…
Second catalytic converter	:	make & reference (1) principle: three way / oxidising / NO_x trap / No_x storage system / Selective Catalyst Reduction…
Particulate trap	:	with/without/not applicable catalysed: yes/no make & reference (1)
Reference and position of oxygen sensor(s)	:	before catalyst / after catalyst
Air injection	:	with/without/not applicable
EGR	:	with/without/not applicable cooled/non-cooled HP/LP
Evaporative emission control system	:	with/without/not applicable
Reference and position of NO_x sensor(s)	:	Before/ after
General description (1)	:	

1.1.7. *HEAT STORAGE DEVICE (if applicable)*

For more than one Heat Storage System, please repeat the point

Heat storage device	:	yes/no
Heat capacity (enthalpy stored J)	:	
Time for heat release (s)	:	

1.1.8. *TRANSMISSION (if applicable)*

For more than one Transmission, please repeat the point

Gearbox	:	manual / automatic / continuous variation
Gear shifting procedure		
Predominant mode	:	yes/no normal / drive / eco/…
Best case mode for CO_2 emissions and fuel consumption (if applicable)	:	
Worst case mode for CO_2 emissions and fuel consumption (if applicable)	:	
Control unit	:	
Gearbox lubricant	:	make and type
Tyres		
Make	:	
Type	:	
Dimensions front/rear	:	
Dynamic circumference (m)	:	
Tyre pressure (kPa)	:	

Transmission ratios (R.T.), primary ratios (R.P.) and (vehicle speed (km/h)) / (engine speed (1 000 (min^{-1})) (V) for each of the gearbox ratios (R.B.).

R.B.	R.P.	R.T.	V_{1000}
1st	1/1		
2nd	1/1		
3rd	1/1		
4th	1/1		
5th	1/1		
…			

1.1.9. *ELECTRIC MACHINE (if applicable)*

For more than one electric machine, please repeat the point

Make	:	
Type	:	
Peak Power (kW)	:	

1.1.10. *TRACTION REESS (if applicable)*

For more than one traction REESS, please repeat the point

Make	:	
Type	:	
Capacity (Ah)	:	
Nominal Voltage (V)	:	

1.1.11. —

1.1.12. *POWER ELECTRONICS (if applicable)*

Can be more than one PE (propulsion converter, low voltage system or charger)

Make	:	
Type	:	
Power (kW)	:	

1.2. **VEHICLE DESCRIPTION**

1.2.1. MASS

Test mass of VH (kg)	:	

1.2.2. ROAD LOAD PARAMETERS

f_0 (N)	:	
f_1 (N/(km/h))	:	
f_2 (N/(km/h)^2)	:	
f_{2_TReg} (N/(km/h)^2)	:	
Cycle energy demand (J)	:	

Road load test report reference	:	
Road load family's identifier	:	

1.2.3. CYCLE SELECTION PARAMETERS

Cycle (without downscaling)	:	Class 1 / 2 / 3a / 3b
Ratio of rated power to mass in running order – 75kg (PMR) (W/kg)	:	(if applicable)
Capped speed process used during measurement	:	yes/no
Maximum speed of the vehicle (km/h)	:	
Downscaling (if applicable)	:	yes/no
Downscaling factor fdsc	:	
Cycle distance (m)	:	
Constant speed (in the case of the shortened test procedure)	:	if applicable

1.2.4. GEAR SHIFT POINT (IF APPLICABLE)

Version of Gear Shift calculation		(indicate the applicable amendment to Regulation (EU) 2017/1151)
Gear shifting	:	Average gear for v ≥ 1 km/h, rounded to four places of decimal
n_{min} drive		
1st gear	:	…min^{-1}
1st gear to 2nd	:	…min^{-1}
2nd gear to standstill	:	…min^{-1}
2nd gear	:	…min^{-1}
3rd gear and beyond	:	…min^{-1}
Gear 1 excluded	:	yes/no
n_95_high for each gear	:	…min^{-1}

n_min_drive_set for acceleration/constant speed phases (n_min_drive_up)	:	…min^{-1}
n_min_drive_set for deceleration phases (nmin_drive_down)	:	…min^{-1}
t_start_phase	:	…s
n_min_drive_start	:	…min^{-1}
n_min_drive_up_start	:	…min^{-1}
use of ASM	:	yes/no
ASM values	:	

2. *TEST RESULTS*

Method of chassis dyno setting	:	Fixed run / iterative / alternative with its own warmup cycle
Dynamometer in 2WD/4WD operation	:	2WD/4WD
For 2WD operation, was the non-powered axle rotating	:	yes/no/not applicable
Dynamometer operation mode		yes/no
Coastdown mode	:	yes/no

2.1 **TEST AT 14 °C**

Date(s) of test(s)			:	(day/month/year)
Place of the test(s)	:			
Height of the lower edge above ground of cooling fan (cm)	:			
Lateral position of fan centre (if modified as request by the manufacturer)	:	in the vehicle centre-line/…		
Distance from the front of the vehicle (cm)	:			
IWR: Inertial Work Rating (%)	:	x,x		
RMSSE: Root Mean Squared Speed Error (km/h)	:	x,xx		

Description of the accepted deviation of the driving cycle	:	Fully operated acceleration pedal

2.1.1. Pollutant emissions of vehicle with at least one combustion engine, of NOVC-HEVs and of OVC-HEVs in case of a charge-sustaining test

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	Particulate Matter	Particle Number
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Measured values							
Limit values							

2.1.2. CO_2 emission of vehicle with at least one combustion engine, of NOVC-HEV and of OVC-HEV in case of a charge-sustaining test

CO_2 emission (g/km)	Low	Medium	High	Extra High	Combined
Measured value $M_{CO_2,p,1}$/ $M_{CO_2,c,2}$					
Measured Speed and distance corrected value $M_{CO_2,p,2b}$ / $M_{CO_2,c,2b}$					
RCB correction coefficient ([1])					
$M_{CO_2,p,3}$ / $M_{CO_2,c,3}$					

([1]) Correction as referred to in Annex B6 - Appendix 2 of UN Regulation No 154 for ICE vehicles, K_{CO_2} for HEVs.

2.2 **TEST AT 23 °C**

Provide information or refer to type 1 test report

Date of tests			:	(day/month/year)
Place of the test	:			
Height of the lower edge above ground of cooling fan (cm)	:			
Lateral position of fan centre (if modified as request by the manufacturer)	:	in the vehicle centre-line/…		

Distance from the front of the vehicle (cm)	:			
IWR: Inertial Work Rating (%)	:	x,x		
RMSSE: Root Mean Squared Speed Error (km/h)	:	x,xx		
Description of the accepted deviation of the driving cycle	:	Fully operated acceleration pedal		

2.2.1. Pollutant emissions of vehicle with at least one combustion engine, of NOVC-HEVs and of OVC-HEVs in case of a charge-sustaining test

Pollutants	CO	THC (a)	NMHC (a)	NO_x	THC + NO_x (b)	Particulate Matter	Particle Number
	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(mg/km)	(#.10^{11}/km)
Final values							
Limit values							

2.2.2. CO_2 emission of vehicle with at least one combustion engine, of NOVC-HEV and of OVC-HEV in case of a charge-sustaining test

CO_2 emission (g/km)	Low	Medium	High	Extra High	Combined
Measured value $M_{CO_2,p,1}$/ $M_{CO_2,c,2}$					
Measured Speed and distance corrected value $M_{CO_2,p,2b}$ / $M_{CO_2,c,2b}$					
RCB correction coefficient ([1])					
$M_{CO_2,p,3}$ / $M_{CO_2,c,3}$					

([1]) Correction as referred to in Appendix 2 of Annex B6 to UN Regulation No 154 for ICE vehicles, and Appendix 2 of Annex B6 to UN Regulation No 154 for HEVs (K_{CO_2}).

2.3 **CONCLUSION**

CO_2 emission (g/km)	Combined
ATCT (14 °C) $M_{CO_2,Treg}$	
Type 1 (23 °C) $M_{CO_2,23}{}^{o}$	
Family correction factor (FCF)	

2.4. **TEMPERATURE INFORMATION OF THE REFERENCE VEHICLE AFTER 23 °C TEST**

Worst case approach with regards to vehicle insulation	:	yes/no ([1])
Worst case approach vehicle cool down	:	yes/no([13])
ATCT family composed of a single Interpolation family	:	yes/no([13])
Engine coolant temperature at the end of soaking time (°C)	:	
Average soak area temperature over the 3 last hours (°C)	:	
Difference between engine coolant end temperature and average soak area temperature of the last 3 hours Δ_{T_ATCT} (°C)	:	
The minimum soaking time t_{soak_ATCT} (s)	:	
Location of temperature sensor	:	
Measured engine temperature	:	oil/coolant

([1]) If 'yes' then the six last lines are not applicable.

Appendix 8b

Road Load Test Report

The following information, if applicable, is the minimum data required for the road load determination test.

Report number

APPLICANT			
Manufacturer			
SUBJECT	Determination of a vehicle road load /…		
Roadload family identifier(s)		:	

Object submitted to tests

	Make	:	
	Type	:	
CONCLUSION	The object submitted to tests complies with the requirements mentioned in the subject.		

PLACE,	DD/MM/YYYY

1. CONCERNED VEHICLE(S)

Make(s) concerned	:	
Type(s) concerned	:	
Commercial description	:	
Maximal speed (km/h)	:	
Powered axle(s)	:	

2. DESCRIPTION OF TESTED VEHICLES

If no interpolation: the worst-case vehicle (regarding energy demand) shall be described

2.1. **Wind tunnel method**

Combination with	:	Flat belt dynamometer / chassis dynamometer

2.1.1. *General*

	Wind tunnel		Dynamometer	
	H_R	L_R	H_R	L_R
Make				
Type				
Version				
Cycle energy demand over a complete WLTC Class 3 cycle (kJ)				
Deviation from production series	—	—		
Mileage (km)	—	—		

Or (in case of roadload matrix family):

Make	:	
Type	:	
Version	:	
Cycle energy demand over a complete WLTC (kJ)	:	
Deviation from production series	:	
Mileage (km)	:	

2.1.2 *Masses*

		Dynamometer
	H_R	L_R
Test mass (kg)		
Average mass m_{av} (kg)		
Value of m_r (kg per axle)		
Category M vehicle: proportion of the vehicle mass in running order on the front axle (%)		
Category N vehicle: weight distribution (kg or %)		

Or (in case of roadload matrix family):

Test mass (kg)	:	
Average mass m_{av}(kg)	:	(average before and after the test)
Technically permissible maximum laden mass	:	
Estimated arithmetic average of the mass of optional equipment	:	

Category M vehicle: proportion of the vehicle mass in running order on the front axle (%)	:	
Category N vehicle: weight distribution (kg or %)	:	

2.1.3 *Tyres*

	Wind tunnel		Dynamometer	
	H_R	L_R	H_R	L_R
Size designation				
Make				
Type				
Rolling resistance				
Front (kg/t)	—	—		
Rear (kg/t)	—	—		
Tyre pressure				
Front (kPa)	—	—		
Rear (kPa)	—	—		

Or (in case of roadload matrix family):

Size designation		
Make	:	
Type	:	
Rolling resistance		
Front (kg/t)	:	
Rear (kg/t)	:	
Tyre pressure		
Front (kPa)	:	
Rear (kPa)	:	

2.1.4. *Bodywork*

	Wind tunnel	
	H_R	L_R
Type	AA/AB/AC/AD/AE/AF BA/BB/BC/BD	
Version		
Aerodynamic devices		
Movable aerodynamic body parts	y/n and list if applicable	
Installed aerodynamic options list		
Delta $(C_D \times A_f)_{LH}$ compared to H_R (m^2)	—	

Or (in case of roadload matrix family):

Body shape description	:	Square box (if no representative body shape for a complete vehicle can be determined)
Frontal area A_{fr} (m^2)	:	

2.2. **ON ROAD**

2.2.1. General

	H_R	L_R
Make		
Type		
Version		
Cycle energy demand over a complete WLTC Class 3 cycle (kJ)		
Deviation from production series		
Mileage		

Or (in case of roadload matrix family):

Make	:	
Type	:	
Version	:	
Cycle energy demand over a complete WLTC (kJ)	:	
Deviation from production series	:	
Mileage (km)	:	

2.2.2. Masses

	H_R	L_R
Test mass (kg)		
Average mass m_{av} (kg)		
Value of m_r (kg per axle)		
Category M vehicle: proportion of the vehicle mass in running order on the front axle (%)		
Category N vehicle: weight distribution (kg or %)		

Or (in case of roadload matrix family):

Test mass (kg)	:	
Average mass m_{av} (kg)	:	(average before and after the test)
Technically permissible maximum laden mass	:	
Estimated arithmetic average of the mass of optional equipment	:	
Category M vehicle: proportion of the vehicle mass in running order on the front axle (%)		
Category N vehicle: weight distribution (kg or %)		

2.2.3. Tyres

	H_R	L_R
Size designation		
Make		
Type		
Rolling resistance		
Front (kg/t)		
Rear (kg/t)		
Tyre pressure		
Front (kPa)		
Rear (kPa)		

Or (in case of roadload matrix family):

Size designation	:	
Make	:	
Type	:	
Rolling resistance		
Front (kg/t)	:	
Rear (kg/t)	:	
Tyre pressure		
Front (kPa)	:	
Rear (kPa)	:	

2.2.4. Bodywork

	H_R	L_R
Type	AA/AB/AC/AD/AE/AF BA/BB/BC/BD	
Version		
Aerodynamic devices		
Movable aerodynamic body parts	y/n and list if applicable	
Installed aerodynamic options list		
Delta $(C_D \times A_f)_{LH}$ compared to H_R (m^2)	—	

Or (in case of roadload matrix family):

Body shape description	:	Square box (if no representative body shape for a complete vehicle can be determined)
Frontal area A_{fr} (m^2)	:	

2.3. **POWERTRAIN**

2.3.1. Vehicle High

Engine code	:	
Transmission type	:	manual, automatic, CVT
Transmission model (manufacturer's codes)	:	(torque rating and no of clutches → to be included in info doc)

Covered transmission models (manufacturer's codes)	:			
Engine rotational speed divided by vehicle speed	:	Gear	Gear ratio	N/V ratio
		1st	1/..	
		2nd	1/..	
		3rd	1/..	
		4th	1/..	
		5th	1/..	
		6th	1/..	
		..		
		..		
Electric machine(s) coupled in position N	:	n.a. (no electric machine or no coastdown mode)		
Type and number of electric machines	:	construction type: asynchronous/ synchronous…		
Type of coolant	:	air, liquid, …		

2.3.2. Vehicle Low

Repeat §2.3.1. with VL data

2.4. **TEST RESULTS**

2.4.1. Vehicle High

Dates of tests	:	dd/mm/yyyy (wind tunnel) dd/mm/yyyy (dynamometer) or dd/mm/yyyy (on road)

ON ROAD

Method of the test	:	coastdown or torque meter method
Facility (name / location / track's reference)	:	
Coastdown mode	:	y/n
Wheel alignment	:	Toe and camber values
Ground clearance ([1])	:	
Vehicle height ([2])	:	
Drivetrain lubricants	:	
Wheel bearing lubricants	:	
Brake adjustment to avoid unrepresentative parasitic drag	:	

Maximum reference speed (km/h)	:	
Anemometry	:	stationary or on board: influence of anemometry (C_D × A) and if it was corrected.
Number of split(s)	:	
Wind	:	average, peaks and direction in conjunction with direction of the test track
Air pressure	:	
Temperature (mean value)	:	
Wind correction	:	y/n
Tyre pressure adjustment	:	y/n
Raw results	:	Torque method: c_0 = c_1 = c_2 = Coastdown method: f_0 f_1 f_2
Final results		Torque method: c_0 = c_1 = c_2 = and f_0 = f_1 = f_2 = Coastdown method: f_0 = f_1 = f_2 =

([1]) As defined in point 4.2. of Appendix 1 of Annex I to Regulation (EU) 2018/858.
([2]) The dimension defined in point 6.3 of Standard ISO 612:1978.

Or

WIND TUNNEL METHOD

Facility (name/location/dynamometer's reference)	:		
Qualification of the facilities	:	Report reference and date	

Dynamometer

Type of dynamometer	:	flat belt or chassis dynamometer
Method	:	stabilised speeds or deceleration method
Warm up	:	warm-up by dyno or by driving the vehicle

Correction of the roller curve	:	(for chassis dynamometer, if applicable)	
Method of chassis dynamometer setting	:	Fixed run / iterative / alternative with its own warmup cycle	
Measured aerodynamic drag coefficient multiplied by the frontal area	:	Velocity (km/h)	$C_D \times A$ (m^2)
		…	…
		…	…
Result	:	f_0 = f_1 = f_2 =	

Or

ROAD LOAD MATRIX ON ROAD

Method of the test	:	coastdown or torque meter method
Facility (name/location/track's reference)	:	
Coastdown mode	:	y/n
Wheel alignment	:	Toe and camber values
Ground clearance ([1])	:	
Vehicle height ([2])	:	
Drivetrain lubricants	:	
Wheel bearing lubricants	:	
Brake adjustment to avoid unrepresentative parasitic drag	:	
Maximum reference speed (km/h)	:	
Anemometry	:	stationary or on board: influence of anemometry ($C_D \times A$) and if it was corrected.
Number of split(s)	:	
Wind	:	average, peaks and direction in conjunction with direction of the test track
Air pressure	:	
Temperature (mean value)	:	

Wind correction	:	y/n
Tyre pressure adjustment	:	y/n
Raw results	:	Torque method: c_{0r} = c_{1r} = c_{2r} = Coastdown method: f_{0r} = f_{1r} = f_{2r} =
Final results		Torque method: c_{0r} = c_{1r} = c_{2r} = and f_{0r} (calculated for vehicle H_M) = f_{2r} (calculated for vehicle H_M) = f_{0r} (calculated for vehicle L_M) = f_{2r} (calculated for vehicle L_M) = Coastdown method: f_{0r} (calculated for vehicle H_M) = f_{2r} (calculated for vehicle H_M) = f_{0r} (calculated for vehicle L_M) = f_{2r} (calculated for vehicle L_M) =

([1]) As defined in point 4.2. of Appendix 1 of Annex I to Regulation (EU) 2018/858.
([2]) The dimension defined in point 6.3 of Standard ISO 612:1978.

Or

ROAD LOAD MATRIX WIND TUNNEL METHOD

Facility (name/location/dynamometer's reference)	:		
Qualification of the facilities	:	Report reference and date	

Dynamometer

Type of dynamometer	:	flat belt or chassis dynamometer
Method	:	stabilised speeds or deceleration method
Warm up	:	warm-up by dyno or by driving the vehicle
Correction of the roller curve	:	(for chassis dynamometer, if applicable)
Method of chassis dynamometer setting	:	Fixed run / iterative / alternative with its own warmup cycle

Measured aerodynamic drag coefficient multiplied by the frontal area	:	Velocity (km/h)	$C_D \times A$ (m^2)
		…	…
		…	…
Result	:	f_{0r} = f_{1r} = f_{2r} = f_{0r} (calculated for vehicle H_M) = f_{2r} (calculated for vehicle H_M) = f_{0r} (calculated for vehicle L_M) = f_{2r} (calculated for vehicle L_M) =	

2.4.2. Vehicle Low

Repeat §2.4.1. with VL data'

Appendix 8c

Template for Test Sheet

The test sheet shall include the test data that are recorded, but not included in any test report.

The test sheet(s) shall be retained by the technical service or the manufacturer for at least 10 years.

The following information, if applicable, is the minimum data required for test sheets.

Information from Annex B4 to UN Regulation No 154			
The coefficients, c_0, c_1 and c_2	:	c_0 = c_1 = c_2 =	
The coastdown times measured on the chassis dynamometer	:	Reference speed (km/h)	Coastdown time (s)
		130	
		120	
		110	
		100	
		90	
		80	
		70	
		60	
		50	
		40	
		30	
		20	
Additional weight may be placed on or in the vehicle to eliminate tyre slippage	:	weight (kg) on/in the vehicle	

The coastdown times after performing the vehicle coast down procedure	:	Reference speed (km/h)	Coastdown time (s)
		130	
		120	
		110	
		100	
		90	
		80	
		70	
		60	
		50	
		40	
		30	
		20	

Information from Annex B5 to UN Regulation No 154

NO_x converter efficiency Indicated concentrations (a); (b), (c), (d), and the concentration when the NO_x analyser is in the NO mode so that the calibration gas does not pass through the converter	:	(a) = (b) = (c) = (d) = Concentration in NO mode =

Information from Annex B6 to UN Regulation No 154

The distance actually driven by the vehicle	:	
For manual shift transmission vehicle, MT vehicle that cannot follow the cycle trace: The deviations from the driving cycle	:	
Drive trace indices:		
The following indices shall be calculated in accordance with the standard SAE J2951(Revised Jan-2014):	: :	
IWR: Inertial Work Rating	:	
RMSSE: Root Mean Squared Speed Error	: : :	
Particulate sample filter weighing		

Filter before the test	:	
Filter after the test	:	
Reference filter	:	
Content of each of the compounds measured after stabilization of the measuring device	:	
Regeneration factor determination		
The number of cycles D between two WLTCs where regeneration events occur	:	
The number of cycles over which emission measurements are made n	:	
The mass emissions measurement M'_{sij} for each compound i over each cycle j	:	
Regeneration factor determination The number of applicable test cycles d measured for complete regeneration	:	
Regeneration factor determination		
Msi	:	
Mpi	:	
Ki	:	

Information from Annex B6a to UN Regulation No 154

ATCT The air temperature and humidity of the test cell measured at the vehicle cooling fan outlet at a minimum frequency of 0,1 Hz.	:	Temperature set point = T_{reg} Actual temperature value ± 3 °C at the start of the test ± 5 °C during the test
The temperature of the soak area measured continuously at a minimum frequency of 0,033 Hz.	:	Temperature set point = T_{reg} Actual temperature value ± 3 °C at the start of the test ± 5 °C during the test
The time of transfer from the preconditioning to the soak area	:	≤ 10 minutes
The time between the end of the Type 1 test and the cool down procedure	:	≤ 10 minutes
The measured soaking time, and shall be recorded in all relevant test sheets.	:	time between the measurement of the end temperature and the end of the Type 1 test at 23 °C

Information from Annex C3 to UN Regulation No 154			
Diurnal testing Ambient temperature during the two diurnal cycles (recorded at least every minute)	:		
Carbon canister puff loss loading Ambient temperature during the first 11-hour profile (recorded at least every 10 minutes)'	:		

(9) Appendix 8d is amended as follows:

(1) the title 'Evaporative emission test report' is replaced by 'Evaporative emissions test report';

(2) point 2.1 is replaced by the following:

'Carbon canister bench ageing

Date of tests	:	(day/month/year)
Place of the test	:	
Carbon canister ageing test report	:	
Loading rate	:	
Fuel specification		
Make	:	
Type	:	name of reference fuel …'
Density at 15 °C (kg/m^3)	:	
Ethanol content (%)	:	
Batch number	:	

(3) point 2.3.5, the last row is deleted;

(4) the following point 2.3.6. is added:

'2.3.6. Demonstrated procedures for alternative conformity of production testing where applicable:

Test for leakage	:	Alternative pressures and/or time or alternative test procedure
Test for venting	:	Alternative pressure and/or time or alternative test procedure
Purge test	:	Alternative flow rate or test procedure
Sealed tank	:	Alternative test procedure'

ANNEX II

'ANNEX II

In-service conformity methodology

1. INTRODUCTION

This Annex sets out the in-service conformity (ISC) methodology for checking compliance against the emission limits for tailpipe (including low temperature) and evaporative emissions throughout the normal life of the vehicle.

2. PROCESS DESCRIPTION

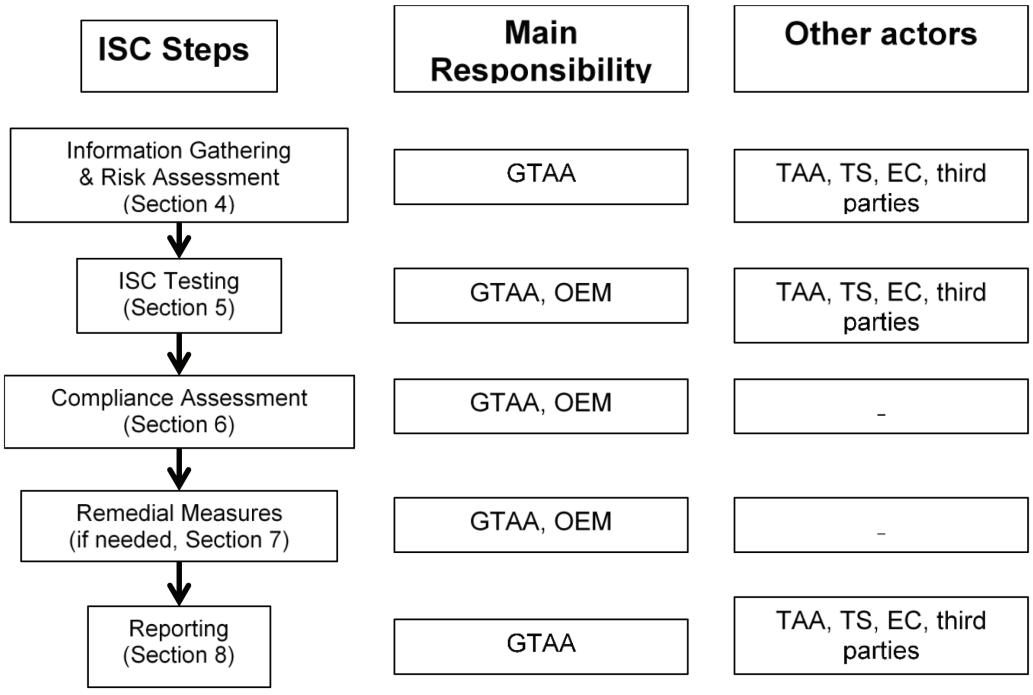


Figure 1

Illustration of the in-service conformity process (where GTAA refers to the granting type- approval authority, OEM refers to the manufacturer, and Other Actors are defined as: TAA refers to type approval authorities other than the one granting the relevant type approval, TS refer to technical services, EC to the Commission, and third parties that meet the requirements laid down in Implementing Regulation (EU) 2022/163)

3. ISC FAMILY DEFINITION

An ISC family shall be composed of the following vehicles:

(a) For tailpipe emissions (Type 1, Type 1a and Type 6 tests), the vehicles covered by the PEMS test family, as described in point 3.3 of Annex IIIA,

(b) For evaporative emissions (Type 4 test), the vehicles included in the evaporative emission family, as described in paragraph 6.6.3. of UN Regulation No. 154.

4. INFORMATION GATHERING AND INITIAL RISK ASSESSMENT

The granting type approval authority and other actors shall gather all relevant information on possible emission non-compliances relevant for deciding which ISC families to check in a particular year. They shall take into account in particular, information indicating vehicle types with high emissions in real driving conditions. That

information shall be obtained by appropriate methods, which may include remote sensing, simplified on-board emissions monitoring systems (SEMS) and testing with PEMS. The number and importance of exceedances observed during such testing may be used to prioritise ISC testing.

As part of the information provided for the ISC checks, each manufacturer shall report to the granting type approval authority on emission-related warranty claims, and any emission-related warranty repair works performed or recorded during servicing, in accordance with a format agreed between the granting type approval authority and the manufacturer at type approval. The information shall detail the frequency and nature of faults for emissions-related components and systems by ISC family. The ISC reports shall be filed at least once a year for each ISC family for the duration of the period during which in-service conformity checks are to be performed in accordance with Article 9(3). The ISC reports shall be made available upon request.

On the basis of the information referred to in the first and second paragraphs, the granting type approval authority shall make an initial assessment of the risk of an ISC family to not comply with the in-service conformity rules and on that basis shall take a decision on which families to test and which types of tests to perform under the ISC provisions. Additionally, the granting type approval authority may randomly choose ISC families to test.

Other actors shall take into account the information collected according to the first paragraph in order to prioritise testing. Additionally, they may randomly choose ISC families to test.

5. ISC TESTING

The manufacturer shall perform ISC testing for tailpipe emissions comprising at least the Type 1 test for all ISC families. The manufacturer may also perform Type 1a, Type 4 and Type 6 tests for all or part of the ISC families. The manufacturer shall report to the granting type-approval authority all results of the ISC testing using the Electronic Platform for in-service conformity described in point 5.9, or other appropriate means where this is not possible.

The granting type approval authority shall check an appropriate number of ISC families each year, as set out in point 5.4. The granting type approval authority shall include all results of the ISC testing in the Electronic Platform for in-service conformity described in point 5.9.

Other actors may perform checks on any number of ISC families each year. They shall report to the granting type approval authority all results of the ISC testing using the Electronic Platform for in-service conformity described in point 5.9, or other appropriate means where this is not possible.

5.1. **Quality assurance of testing**

The granting type approval authority shall annually audit the ISC checks performed by the manufacturer. The granting type approval authority may also audit the ISC checks performed by third parties. The audit shall be based on the information provided by the manufacturers, or third parties, which shall include at least the detailed ISC report in accordance with Appendix 3. The granting type approval authority may require the manufacturers, or third parties to provide additional information.

5.2. **Disclosure of tests results**

The granting type approval authority shall communicate the results of the compliance assessment and remedial measures for a particular ISC family to other actors which provided test results for that family as soon as they become available.

The results of the tests, including the detailed data for all vehicles tested, may only be disclosed to the public after the publication by the granting type approval authority of the annual report or the results of an individual ISC procedure or after the closure of the statistical procedure (see point 5.10.) without a result. If the results of the ISC tests undertaken by other actors are published, reference shall be made to the annual report by the granting type approval authority which included them.

5.3. **Types of tests**

ISC testing shall only be performed on vehicles selected in accordance with Appendix 1.

ISC testing with the Type 1 test shall be performed in accordance with Annex XXI.

ISC testing with the Type 1a test shall be performed in accordance with Annex IIIA, Type 4 tests shall be performed in accordance with Appendix 2 to this Annex and Type 6 tests shall be performed in accordance with Annex VIII.

5.4. **Frequency and scope of ISC testing**

The time period between commencing two in-service conformity checks by the manufacturer for a given ISC family shall not exceed 24 months.

The frequency of ISC testing performed by the granting type approval authority shall be based on a risk assessment methodology consistent with the international standard ISO 31000:2018 — Risk Management — Principles and guidelines which shall include the results of the initial assessment made according to point 4.

Each granting type approval authority shall perform both the Type 1 and Type 1a tests on a minimum of 5 % of the ISC families per manufacturer per year or at least two ISC families per manufacturer per year, where available. The requirement for testing a minimum of 5 % or at least two ISC families per manufacturer per year shall not apply to small volume manufacturers. The granting type approval authority shall ensure the widest possible coverage of ISC families and vehicle age in a particular in-service conformity family in order to ensure compliance according to Article 9, paragraph 3. The granting type approval authority shall complete the statistical procedure for each ISC family it has started within 12 months.

Type 4 or Type 6 ISC tests shall have no minimum frequency requirements.

5.5. **Funding for ISC testing by the granting type approval authorities**

The granting type approval authority shall ensure that sufficient resources are available to cover the costs for in-service conformity testing. Without prejudice to national law, those costs shall be recovered by fees that can be levied on the manufacturer by the granting type approval authority. Such fees shall cover ISC testing of up to 5 % of the in-service conformity families per manufacturer per year or at least two ISC families per manufacturer per year.

5.6. **Testing plan**

When performing testing for ISC, the granting type approval authority shall draft a testing plan. In the case of Type 1a testing, that plan shall include testing to check ISC compliance under a wide range of conditions in accordance with Annex IIIA.

5.7. **Selection of vehicles for ISC testing**

The information gathered shall be sufficiently comprehensive to ensure that in-service performance can be assessed for vehicles that are properly maintained and used. The tables in Appendix 1 shall be used to decide whether the vehicle can be selected for the purposes of ISC testing. During the check against the tables in Appendix 1, some vehicles may be declared as faulty and not tested during ISC, when there is evidence that parts of the emission control system were damaged.

The same vehicle may be used to perform and establish reports from more than one type of tests (Type 1, Type 1a, Type 4, Type 6) but only the first valid test of each type shall be taken into account for the statistical procedure.

5.7.1. *General requirements*

The vehicle shall belong to an ISC family as described in point 3 and shall comply with the checks set out in the table in Appendix 1. It shall be registered in the Union and have been driven in the Union for at least 90 % of its driving time. The emissions testing may be done in a different geographical region from that where the vehicles have been selected. In case of ISC testing conducted by the manufacturer, with the agreement of the granting type approval authority, vehicles registered in a non-EU country may be tested, if they belong to the same ISC family and are accompanied by a certificate of conformity.

The vehicles selected shall be accompanied by a maintenance record which shows that the vehicle has been properly maintained and has been serviced in accordance with the manufacturer's recommendations with only original parts used for the replacement of emissions related parts.

Vehicles exhibiting indications of abuse, improper use that could affect its emissions performance, tampering or conditions that may lead to unsafe operation shall be excluded from ISC.

The vehicles shall not have undergone aerodynamic modifications that cannot be removed prior to testing.

A vehicle shall be excluded from ISC testing if the information stored in the on-board computer shows that the vehicle was operated after a fault code was displayed and a repair was not carried out in accordance with manufacturer specifications.

A vehicle shall be excluded from ISC testing if the fuel from the vehicle tank does not meet the applicable standards laid down in Directive 98/70/EC of the European Parliament and of the Council [1] or if there is evidence or record of fuelling with the wrong type of fuel.

5.7.2. *Vehicle Examination and Maintenance*

Diagnosis of faults and any normal maintenance necessary in accordance with Appendix 1 shall be performed on vehicles accepted for testing, prior to or after proceeding with ISC testing.

The following checks shall be carried out: OBD checks (performed before or after the test), visual checks for lit malfunction indicator lamps, checks on air filter, all drive belts, all fluid levels, radiator and fuel filler cap, all vacuum and fuel system hoses and electrical wiring related to the after-treatment system for integrity; checks on ignition, fuel metering and pollution control device components for maladjustments and/or tampering.

If the vehicle is within 800 km of a scheduled maintenance service, that service shall be performed.

The window washer fluid shall be removed before the Type 4 test and replaced with hot water.

A fuel sample shall be collected and kept in accordance with the requirements of Annex IIIA for further analysis in case of fail.

All faults shall be recorded. When the fault is on the pollution control devices then the vehicle shall be reported as faulty and not be used further for testing, but the fault shall be taken into account for the purposes of the compliance assessment performed in accordance with point 6.1.

5.8. **Sample size**

When manufacturers apply the statistical procedure set out in point 5.10 for the Type 1 test, the number of sample lots shall be set on the basis of the annual sales volume of an in-service family in the Union, as described in the following table:

Table 1

Number of sample lots for ISC testing with Type 1 tests

EU Registrations per calendar year of vehicles in the sampling period	Number of sample lots (for Type 1 tests)
up to 100 000	1
100 001 to 200 000	2
above 200 000	3

[1] Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC (OJ L 350, 28.12.1998, p. 58).

Each sample lot shall include enough vehicle types, in order to ensure that at least 20 % of the total registrations of this PEMS family in Europe for the previous year are covered. In case the same PEMS family is shared between more brands, then all brands shall be tested. When a family requires more than one sample lot to be tested, the vehicles in the second and third sample lots shall select vehicles used in different ambient and/or typical use conditions from those selected for the first sample.

5.9. **Use of the Electronic Platform for in-service conformity and access to data required for testing**

The Commission shall set up an electronic platform in order to facilitate the exchange of data between on the one side, the manufacturers, other actors and on the other side the granting type approval authority and the taking of the decision on the sample fail or pass.

The manufacturer shall complete the package on Testing Transparency referred to in Article 5 (12) in the format specified in Tables 1 and 2 of Appendix 5 and in Table 2 in this point and transmit it to the type-approval authority which grants the emission type-approval. Table 2 of Appendix 5 shall be used in order to allow the selection of vehicles from the same family for testing and along with Table 1 of Appendix 5 provide sufficient information for vehicles to be tested.

Once the electronic platform referred to in the first paragraph becomes available, the type-approval authority which grants the emission type-approval shall upload the information in Tables 1 and 2 of Appendix 5 to this platform within 5 working days of receiving it.

All information in Tables 1 and 2 of Appendix 5 shall be accessible to the public in an electronic form free of charge.

The following information shall also be part of the package on Testing Transparency and shall be provided by the manufacturer free-of-charge within 5 working days of the request by other actors.

Table 2

Sensitive information

ID	Input	Description
1.	Special Procedure for conversion of vehicles (4WD to 2WD) for dyno testing if available	As defined in paragraph 2.4.2.4. of Annex B6 to UN Regulation 154
2.	Dyno mode instructions, if available	How to enable the dyno mode as done also during TA tests
3.	Coastdown mode used during the TA tests	If the vehicle has coastdown mode instructions how to enable this mode
4.	Battery discharge procedure (OVC-HEV, PEV)	OEM procedure to deplete battery for preparing OVC-HEV for charge sustaining tests, and PEV to charge the battery
5.	Procedure to deactivate all auxiliaries	If used during TA
6.	Procedure to measure current and voltage of all REESS with the use of external equipment	As defined in Appendix 3 of Annex B8 to UN Regulation 154 To measure current and voltage independently of on-board data, OEM provides procedure, description of current and voltage access points and list of devices used for current and voltage measurement during type approval.

5.10. **Statistical Procedure**

5.10.1. *General*

The verification of in-service conformity shall rely on a statistical method following the general principles of sequential sampling for inspection by attributes. The minimum sample size for a pass result is three vehicles, and the maximum cumulative sample size is ten vehicles for the Type 1 and Type 1a tests.

For the Type 4 and Type 6 tests a simplified method may be used, where the sample shall consist of three vehicles and shall be considered a fail if all three vehicles fail to pass the test, and a pass if all three vehicles pass the test. In cases where two out of three passed or failed, the type approval authority may decide to conduct further tests or proceed with assessing the compliance in accordance with point 6.1.

Test results shall not be multiplied by deterioration factors.

For vehicles that have a Declared Maximum RDE Values reported in point 48.2 of the Certificate of Conformity, as described in Annex VIII of Regulation (EU) 2020/683 which is lower than the emission limits set out in Table 2 of Annex I to Regulation (EC) No 715/2007, the conformity shall be checked against these Declared Maximum RDE Values. If the sample is found not to conform with the Declared Maximum RDE Values, the granting type approval authority shall require the manufacturer to take corrective actions.

Prior to the performance of the first ISC test, the manufacturer, or other actors shall notify the intent of performing in-service conformity testing of a given vehicle family to the granting type approval authority. Upon this notification, the granting type approval authority shall open a new statistical folder to process the results for each relevant combination of the following parameters for that particular party/or that pool of parties: vehicle family, emissions test type and pollutant. Separate statistical procedures shall be opened for each relevant combination of those parameters.

The granting type approval authority shall incorporate in each statistical folder only the results provided by the relevant party. The granting type approval authority shall keep a record of the number of tests performed, the number of failed and passed tests and other necessary data to support the statistical procedure.

Whereas more than one statistical procedure can be open at the same time for a given combination of test type and vehicle family, a party shall only be allowed to provide test results to one open statistical procedure for a given combination of test type and vehicle family. Each test shall be reported only once and all tests (valid, not valid, fail or pass, etc.) shall be reported.

Each ISC statistical procedure shall remain open until an outcome is reached when the statistical procedure arrives to a pass or fail decision for the sample in accordance with point 5.10.5. However, if an outcome is not reached within 12 months of the opening of a statistical folder, the granting type approval authority shall close the statistical folder unless it decides to complete testing for that statistical folder within the following 6 months.

The functions described above shall be executed directly in the Electronic Platform once the relevant functions are available.

5.10.2. *Pooling of ISC results*

Test results from other actors may be pooled for the purposes of a common statistical procedure. The pooling of test results shall require the written consent from all the interested parties providing test results to a pool of results, and a notification to the type approval authorities, and to the electronic platform when available, prior to the start of testing. One of the parties shall be designated as leader of the pool and be responsible for data reporting and communication with the granting type approval authority.

5.10.3. *Pass/Fail/Invalid outcome for a single test*

An ISC emissions test shall be considered as "passed" for one or more pollutants when the emissions result is equal or below the emission limit set out in Table 2 of Annex I of Regulation (EC) No 715/2007 for that type of test.

An emissions test shall be considered as "failed" for one or more pollutants when the emissions result is greater than the corresponding emission limit for that type of test. Each failed test result shall increase the "f" count (see point 5.10.5) by 1 for that statistical instance.

An ISC emissions test shall be considered invalid if it does not respect the requirements of the tests referred to in point 5.3. Invalid test results shall be excluded from the statistical procedure and the test shall be repeated with the same vehicle in order to have a valid test.

The results of all ISC tests shall be submitted to the granting type approval authority within ten working days from the execution of each test on a single vehicle. The test results shall be accompanied by a comprehensive test report at the end of the tests. The results shall be incorporated in the sample in chronological order of execution.

The granting type approval authority shall incorporate all valid emission test results to the relevant open statistical procedure until a "sample fail" or a "sample pass" outcome is reached in accordance with point 5.10.5.

5.10.4. *Treatment of Outliers*

The presence of outlying results in the sample statistical procedure may lead to a "fail" outcome in accordance with the procedures described below:

Outliers shall be categorised as mild, intermediate or extreme.

An emissions test result shall be considered as a mild outlier if it is more than the applicable emission limit but less than 1,3 times the applicable emission limit. The presence of a mild outlier only counts in the number of failed results in point 5.10.5. below.

An emissions test result shall be considered as an intermediate outlier if it is equal or greater than 1,3 times the applicable emission limit. The presence of two such outliers in a sample shall lead to a fail of the sample.

An emissions result shall be considered as an extreme outlier if it is equal or greater than 2,5 times the applicable emission limit. The presence of one such outlier in a sample shall lead to a fail of the sample. In such case, the plate number of the vehicle shall be communicated to the manufacturer and to the granting type approval authority. This possibility shall be communicated to the vehicle owners before testing.

5.10.5. *Pass/Fail decision for a sample*

For the purposes of deciding on a pass/fail result for the sample, "p" is the count of passed results, and "f" is the count of failed results. Each passed test result shall increase the "p" count by 1 and each failed test result shall increase the "f" count by 1 for the relevant open statistical procedure.

Upon the incorporation of valid emission test results to an open instance of the statistical procedure, the type approval authority shall perform the following actions:

— update the cumulative sample size "n" for that instance to reflect the total number of valid emissions tests incorporated to the statistical procedure;

— following an evaluation of the results, update the count of passed results "p" and the count of failed results "f";

— compute the number of extreme and intermediate outliers in the sample in accordance with point 5.10.4.;

— check whether a decision is reached with the procedure described below.

The decision depends on the cumulative sample size "n", the passed and failed result counts "p" and "f", as well as the number of intermediate and/or extreme outliers in the sample. For the decision on a pass/fail of an ISC sample the granting type approval authority shall use the decision chart in Figure 2 for vehicles based on types approved as of 1 January 2020 and the decision chart in Figure 2.a for vehicles based on types approved until 31 December 2019. The charts indicate the decision to be taken for a given cumulative sample size "n" and failed count result "f".

Two decisions are possible for a statistical procedure for a given combination of vehicle family, emissions test type and pollutant:

"Sample pass" outcome shall be reached when the applicable decision chart from Figure 2 or Figure 2.a gives a "PASS" outcome for the current cumulative sample size "n" and the count of failed results "f".

"Sample fail" decision shall be reached, for a given cumulative sample size "n", when at least one of the following conditions is fulfilled:

— the applicable decision chart from Figure 2 or Figure 2.a gives a "FAIL" decision for the current cumulative sample size "n" and the count of failed results "f";

— there are two "FAIL" decisions with intermediate outliers;

— there is one "FAIL" decision with an extreme outlier.

If no decision is reached, the statistical procedure shall remain open and further results shall be incorporated into it until a decision is reached or the procedure is closed in accordance with point 5.10.1.

Figure 2

Decision chart for the statistical procedure for vehicles based on types approved as of 1 January 2020 (where "UND" means undecided)

Failed result count f	10								FAIL
	9							FAIL	FAIL
	8						FAIL	FAIL	FAIL
	7					FAIL	FAIL	FAIL	FAIL
	6				FAIL	FAIL	FAIL	FAIL	FAIL
	5			FAIL	FAIL	FAIL	UND	UND	PASS
	4		FAIL	FAIL	UND	UND	UND	UND	PASS
	3	FAIL	FAIL	UND	UND	UND	UND	PASS	PASS
	2	UND	UND	UND	UND	PASS	PASS	PASS	PASS
	1	UND	PASS	PASS	PASS	PASS	PASS	PASS	PASS
	0	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
		3	4	5	6	7	8	9	10
	Cumulative sample size n								

Figure 2.a

Decision chart for the statistical procedure for vehicles type approved until 31 December 2019 (where "UND" means undecided)

Failed result count f	10								FAIL
	9							FAIL	FAIL
	8						FAIL	FAIL	FAIL
	7					FAIL	FAIL	FAIL	FAIL
	6				FAIL	FAIL	FAIL	FAIL	FAIL
	5			FAIL	UND	UND	UND	UND	PASS
	4		UND	UND	UND	UND	UND	PASS	PASS
	3	UND	UND	UND	UND	UND	PASS	PASS	PASS
	2	UND	UND	UND	PASS	PASS	PASS	PASS	PASS
	1	UND	PASS	PASS	PASS	PASS	PASS	PASS	PASS
	0	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
		3	4	5	6	7	8	9	10
	Cumulative sample size n								

5.10.6. *ISC for completed vehicles and multistage special purpose vehicles*

The manufacturer of the base vehicle shall determine the allowed values for the parameters listed in Table 3. The allowed Parameter Values for each family shall be recorded in the information document of the emissions type approval (see Appendix 3 to Annex I) and in the Transparency list 1 of Appendix 5. The final-stage manufacturer shall only be allowed to use the base vehicle emission values if the completed vehicle remains within the allowed Parameter Values. The parameter values for each final vehicle shall be recorded in its Certificate of Conformity.

Table 3

Allowed Parameter Values for multistage and multistage special purpose vehicles to use the base vehicle emission type approval

Parameter Values	Allowed values from - to
Final Vehicle actual mass (in kg)	
Final Vehicle technically permissible maximum laden mass (in kg)	
Frontal area for final vehicle (in cm^2)	
Rolling resistance (kg/t)	
Projected frontal area of air entrance of the front grille (in cm^2)	

If a completed or multistage special purpose vehicle is tested and the result of the test is below the applicable emission limit, the vehicle shall be considered as a pass for the ISC family for the purposes of point 5.10.3.

If the result of the test on a completed or multistage special purpose vehicle exceeds the applicable emission limits but is not higher than 1,3 times the applicable emission limits, the tester shall examine whether that vehicle complies with the values in Table 3. Any non-compliance with these values shall be reported to the granting type approval authority. If the vehicle does not comply with those values, the granting type approval authority shall investigate the reasons for the non-compliance and take the appropriate measures regarding the manufacturer of the completed or multistage special purpose vehicle to restore conformity, including the withdrawal of the type-approval. If the vehicle complies with the values in Table 3, it shall be considered as a flagged vehicle for the in-service conformity family for the purposes of point 6.1.

If the result of the test exceeds 1,3 times the applicable emission limits, shall be considered as a fail for the in-service conformity family for the purposes of point 6.1., but not as an outlier for the relevant ISC family. If the completed or multistage special purpose vehicle does not comply with the values in Table 3, this shall be reported to the granting type approval authority, who shall investigate the reasons for the non-compliance and take the appropriate measures regarding the manufacturer of the completed or multistage special purpose vehicle to restore conformity, including the withdrawal of the type-approval.

6. COMPLIANCE ASSESSMENT

6.1. Within 10 working days of the end of the ISC testing for the sample as referred to in point 5.10.5, the granting type approval authority shall start detailed investigations with the manufacturer in order to decide whether the ISC family (or part of it) complies with the ISC rules and whether it requires remedial measures. For multistage or special purpose vehicles the granting type approval authority shall also perform detailed investigations when there are at least three faulty vehicles with the same fault or five flagged vehicles in the same ISC family, as set out in point 5.10.6.

6.2. The granting type approval authority shall ensure that sufficient resources are available to cover the costs for compliance assessment. Without prejudice to national law, those costs shall be recovered by fees that can be levied on the manufacturer by the granting type approval authority. Such fees shall cover all testing or auditing needed in order for an assessment on compliance to be reached.

6.3. On the request of the manufacturer, the granting type approval authority may extend the investigations to vehicles in service of the same manufacturer belonging to other ISC families which are likely to be affected by the same defects.

6.4. The detailed investigation shall take no more than 60 working days after the start of the investigation by the granting type approval authority. The granting type approval authority may conduct additional ISC tests designed to determine why vehicles have failed during the original ISC tests. The additional tests shall be conducted under similar conditions as the original failed ISC tests.

Upon the request of the granting type approval authority, the manufacturer shall provide additional information, showing in particular the possible cause of the failures, which parts of the family might be affected, whether other families might be affected, or why the problem which caused the failure at the original ISC tests is not related to in-service conformity, if applicable. The manufacturer shall be given the opportunity to prove that the in-service conformity provisions have been complied with.

6.5. Within the deadline set out in point 6.4, the granting type approval authority shall take the decision on the compliance or the non-compliance. In case of non-compliance, the granting type approval authority shall define the remedial measures for the ISC family according to point 7. It shall notify them to the manufacturer.

7. REMEDIAL MEASURES

7.1. The manufacturer shall establish a plan of remedial measures and submit it to the granting type approval authority within 45 working days of the decision on the compliance or non-compliance referred to in point 6.5. That period may be extended by up to an additional 30 working days where the manufacturer demonstrates to the granting type approval authority that further time is required to investigate the non-compliance.

7.2. The remedial measures required by the granting type approval authority shall include reasonably designed and necessary tests on components and vehicles in order to demonstrate the effectiveness and durability of the remedial measures.

7.3. The manufacturer shall assign a unique identifying name or number to the plan of remedial measures. The plan of remedial measures shall include at least the following:

(a) a description of each vehicle emission type included in the plan of remedial measures;

(b) a description of the specific modifications, alterations, repairs, corrections, adjustments or other changes to be made to bring the vehicles into conformity including a brief summary of the data and technical studies which support the decision of the manufacturer as to the particular remedial measures to be taken;

(c) a description of the method by which the manufacturer will inform the vehicle owners of the planned remedial measures;

(d) a description of the proper maintenance or use, if any, which the manufacturer stipulates as a condition of eligibility for repair under the plan of remedial measures, and an explanation of the need for such condition;

(e) a description of the procedure to be followed by vehicle owners to obtain correction of the non-conformity; that description shall include a date after which the remedial measures shall be taken, the estimated time for the workshop to perform the repairs and where they can be done;

(f) an example of the information transmitted to the vehicle owner;

(g) a brief description of the system which the manufacturer uses to assure an adequate supply of component or systems for fulfilling the remedial action, including information on when an adequate supply of the components, software or systems needed to initiate the application of remedial measures will be available;

(h) an example of all instructions to be sent to the repair shops which will perform the repair;

(i) a description of the impact of the proposed remedial measures on the emissions, fuel consumption, driveability, and safety of each vehicle emission type, covered by the plan of remedial measures, including supporting data and technical studies;

(j) where the plan of remedial measures includes a recall, a description of the method for recording the repair shall be submitted to the granting type approval authority. If a label is used, an example of it shall also be submitted.

For the purposes of point (d), the manufacturer may not impose maintenance or use conditions which are not demonstrably related to the non-conformity and the remedial measures.

7.4. The repair shall be done expediently, within a reasonable time after the vehicle is received by the manufacturer for repair. Within 15 working days of receiving the proposed plan of remedial measures, the granting type approval authority shall approve it or require a new plan in accordance with point 7.5.

7.5. When the granting type approval authority does not approve the plan of remedial measures, the manufacturer shall develop a new plan and submit it to the granting type approval authority within 20 working days of notification of the decision of the granting type approval authority.

7.6. If the granting type approval authority does not approve the second plan submitted by the manufacturer, it shall take all appropriate measures, in accordance with Article 53 of Regulation (EU) 2018/858, to restore conformity, including withdrawal of type approval where necessary.

7.7. The granting type approval authority shall notify its decision on remedial measures to all Member States and the Commission within 5 working days.

7.8. The remedial measures shall apply to all vehicles in the ISC family (or other relevant families identified by the manufacturer in accordance with point 6.2) that are likely to be affected by the same defect. The granting type approval authority shall decide if it is necessary to amend the type approval.

7.9. The manufacturer is responsible for the execution of the approved plan of remedial measures in all Member States and for keeping a record of every vehicle removed from the market or recalled and repaired and the workshop which performed the repair.

7.10. The manufacturer shall keep a copy of the communication with the customers of affected vehicles related to the plan of remedial measures. The manufacturer shall also maintain a record of the recall campaign, including the total number of vehicles affected per Member State and the total number of vehicles already recalled per Member State, along with an explanation of any delays in the application of the remedial measures. The manufacturer shall provide that record of the recall campaign to the granting type approval authority, the type approval authorities of each Member State and the Commission every two months.

7.11. Member States shall take measures to ensure that the approved plan of remedial measures is applied within two years to at least 90 % of affected vehicles registered in their territory.

7.12. The repair and modification or addition of new equipment shall be recorded in a certificate provided to the vehicle owner, which shall include the number of the remedial campaign.

8. ANNUAL REPORT BY THE GRANTING TYPE APPROVAL AUTHORITY

The granting type approval authority shall make available on a publicly accessible website, free of charge and without the need for the user to reveal their identity or sign up, a report with the results of all the finalised ISC investigations of the previous year, at the latest by the 31 March of each year. In case some ISC investigations of the previous year are still open by that date, they shall be reported as soon as the investigation is finalised. The report shall contain at least the items listed in Appendix 4.

Appendix 1

Criteria for vehicle selection and failed vehicles decision

The vehicle survey shall be used in order to select properly maintained and used vehicles for testing in ISC. Vehicles that have one or more of the exclusion criteria below shall be excluded from testing or otherwise repaired and then selected.

Selection of Vehicles for In-Service Conformity Emissions Testing

			Confidential
Date:			*x*
Name of investigator:			*x*
Location of test:			*x*
Country of registration (in EU only):		*x*	
	x = Exclusion Criteria	*X = Checked and reported*	
Vehicle Characteristics			
Registration plate number:		*x*	*x*
Mileage and age of vehicle: *The vehicle must comply with the rules in regards to mileage and age in Article 9, otherwise it cannot be selected. The age of the vehicle counts from the date of first registration*	*x*		
Date of first registration:		x	
VIN:		*x*	x
Emission class and character:		*x*	
Country of registration: *The vehicle must be registered in the EU*	*x*	*x*	
Model:		*x*	
Engine code:		*x*	

Engine volume (l):		*x*	
Engine power (kW):		*x*	
Gearbox type (auto/manual):		*x*	
Drive axle (FWD/AWD/RWD):		*x*	
Tyre size (front and rear if different):		*x*	
Is the vehicle involved in a recall or service campaign? *If yes: Which one? Has the campaign repairs already been done?* *The repairs must have been done before the start of the ISC testing*	*x*	*x*	
Vehicle Owner Interview *(the owner will only be asked the main questions and shall have no knowledge of the implications of the replies)*			
Name of the owner (only available to the accredited inspection body or laboratory/technical service)			x
Contact (address / telephone) (only available to the accredited inspection body or laboratory/technical service)			x
How many owners did the vehicle have?		*x*	
Did the odometer not work? *If yes, the vehicle cannot be selected.*	*x*		
Was the vehicle used for one of the following?			
As car used in show-rooms?		*x*	
As a taxi?		*x*	
As delivery vehicle?		*x*	

For racing / motor sports?	*x*		
As a rental car?		*x*	
Has the vehicle carried heavy loads over the specifications of the manufacturer? *If yes, the vehicle cannot be selected.*	*x*		
Have there been major engine or vehicle repairs?		*x*	
Have there been unauthorised major engine or vehicle repairs? *If yes, the vehicle cannot be selected.*	*x*		
Has there been an unauthorised power increase/tuning? *If yes, the vehicle cannot be selected.*	*x*		
Was any part of the emissions after-treatment and/or the fuel system replaced? Were original parts used? If original parts were not used, the vehicle cannot be selected.	*x*	*x*	
Was any part of the emissions after-treatment system permanently removed? *If yes, the vehicle cannot be selected*	*x*		
Were there any unauthorised devices installed (Urea killer, emulator, etc)? *If yes, the vehicle cannot be selected*	*x*		
Was the vehicle involved in a serious accident? Provide a list of damage and repairs done afterwards		*x*	
Has the car been used with a wrong fuel type (i.e. gasoline instead of diesel) in the past? Has the car been used with non-commercially available EU-quality fuel (black market, or blended fuel?) *If yes, the vehicle cannot be selected.*	*x*		
Did you use air-freshener, cockpit-spray, brake cleaner or other high hydro-carbon emission source around the vehicle during the last month? If yes, the vehicle cannot be selected for evaporative testing.	*x*		
Was there a gasoline spill in the inside or outside of the vehicle during the last 3 months? *If yes, the vehicle cannot be selected for evaporative testing.*	*x*		
Did anyone smoke in the car during the last 12 months? *If yes, the vehicle cannot be selected for evaporative testing*	*x*		

Did you apply corrosion protection, stickers, under seal protection, on any other potential sources of volatile compounds to the car? *If yes, the vehicle cannot be selected for evaporative testing*	*x*		
Was the car repainted? *If yes, the vehicle cannot be selected for evaporative testing*	*x*		
Where do you use your vehicle more often?			
% motorway		*x*	
% rural		*x*	
% urban		*x*	
Did you drive the vehicle in a non EU Member State for more than 10 % of driving time? *If yes, the vehicle cannot be selected*	*x*	—	
In which country was the vehicle refuelled during the last two times? *If the vehicle was refuelled the last two times outside a state applying the EU Fuel Standards, the vehicle cannot be selected.*	*x*		
Has a fuel additive, not approved by the manufacturer been used? *If yes then the vehicle cannot be selected.*	*x*		
Has the vehicle been maintained and used in accordance with the manufacturer's instructions? *If not, the vehicle cannot be selected.*	*x*		
Full service and repair history including any re-works *If the full documentation cannot be provided, the vehicle cannot be selected.*	*x*		

	Vehicle Examination and Maintenance	*X = Exclusion Criteria/ F = Faulty Vehicle*		*X = checked and reported*
1	*Fuel tank level (full / empty)* Is the fuel reserve light ON? *If yes, refuel before test.*			*x*
2	*Are there any warning lights on the instrument panel activated indicating a vehicle or exhaust after-treatment system malfunctioning that cannot be resolve by normal maintenance? (Malfunction Indication Light, Engine Service Light, etc?)* *If yes, the vehicle cannot be selected*	*x*		
3	*Is the SCR light on after engine-on?* *If yes, the AdBlue should be filled in, or the repair executed before the vehicle is used for testing.*	*x*		
4	*Visual examination exhaust system* Check leaks between exhaust manifold and end of tailpipe. Check and document (with photos) *If there is damage or leaks, the vehicle is declared faulty.*	*F*		
5	*Exhaust gas relevant components* Check and document (with photos) all emissions relevant components for damage. *If there is damage, the vehicle is declared faulty.*	*F*		

6	*Evaporative system* Pressurize fuel-system (from canister side), testing for leaks in a constant ambient temperature environment, FID sniff test around and in the vehicle. *If the FID sniff test is not passed, the vehicle is declared faulty*.	*F*		
7	*Fuel sample* Collect fuel sample from the fuel tank.			*x*
8	*Air filter and oil filter* Check for contamination and damage and change if damaged or heavily contaminated or less than 800 km before the next recommended change.			*x*
9	*Window washer fluid (only for evaporative testing)* Remove window washer fluid and fill tank with hot water.			*x*
10	*Wheels (front & rear)* Check whether the wheels are freely moveable or blocked by the brake. *If not, the vehicle cannot be selected*.	*x*		
11	*Tyres (only for evaporative testing)* Remove spare tyre, change to stabilised tyres if the tyres were changes less than 15 000 km ago. Use summer and all season tyres only.			*x*

12	*Drive belts & cooler cover* *In case of damage, the vehicle is declared faulty. Document with photos*	*F*		
13	*Check fluid levels* Check the max. and min. levels (engine oil, cooling liquid) / top up if below minimum			*x*
14	*Filler flap (only for evaporative testing)* Check overfill line within filler flap is completely free of residues or flush the hose with hot water.			*x*
15	*Vacuum hoses and electrical wiring* Check all for integrity. *In case of damage, the vehicle is declared faulty. Document with photos*	*F*		
16	*Injection valves / cabling* Check all cables and fuel lines. *In case of damage, the vehicle is declared faulty. Document with photos*	*F*		

17	*Ignition cable (gasoline)* Check spark plugs, cables, etc. In case of damage, replace them.			*x*
18	*EGR & Catalyst, Particle Filter* Check all cables, wires and sensors. *In case of tampering, the vehicle cannot be selected.* *In case of damage the vehicle is declared Faulty, Document with photos*	*x/F*		
19	*Safety condition* Check tyres, vehicle's body, electrical and braking system status are in safe conditions for the test and respect road traffic rules. *If not, the vehicle cannot be selected.*	*x*		
20	*Semi-trailer* Are there electric cables for semi-trailer connection, where required?			*x*
21	*Aerodynamic modifications* Verify no aftermarket aerodynamics modification that cannot be removed before testing was made (roof boxes, load racking, spoilers, etc.) and no standard aerodynamics components are missing (front deflectors, diffusers, splitters, etc.). *If yes, the vehicle cannot be selected. Document with photos.*	*x*		

22	*Check if less than 800 km away from next scheduled service, if yes, then perform the service.*			*x*
23	*All checks requiring OBD connections to be performed before and/or after the end of testing*			
24	*Powertrain Control Module calibration part number and checksum*			*x*
25	*OBD diagnosis (before or after the emissions test)* Read Diagnostic Trouble Codes & Print error log			*x*
26	*OBD Service Mode 09 Query (before or after the emissions test)* Read Service Mode 09. Record the information.			*x*
27	*OBD mode 7 (before or after the emissions test)* Read Service Mode 07. Record the information			
	Remarks for: Repair / replacement of components / part numbers			

Appendix 2

Rules for performing type 4 tests during in-service conformity

Type 4 tests for in-service conformity shall be performed in accordance with Annex VI (or Annex VI of Regulation (EC) No 692/2008 where applicable), with the following exceptions:

— vehicles tested with the Type 4 test shall be at least 12 months of age.

— the canister shall be considered aged and therefore the Canister Bench Ageing procedure shall not be followed.

— the canister shall be loaded outside the vehicle, following the procedure described for this purpose in Annex VI and shall be removed and mounted to the vehicle following the repair instructions of the manufacturer. An FID sniff test (with results less than 100 ppm at 20 °C) shall be made as close as possible to the canister before and after the loading to confirm that the canister is mounted properly.

— the tank shall be considered aged and therefore no Permeability Factor shall be added in the calculation of the result of the Type 4 test.

Appendix 3

ISC Report

The following information shall be included in the detailed ISC report:

1. Test Date

2. Unique Number of ISC Report

3. Date of approval by authorised representative

4. Date of transmission to GTAA or upload to Electronic Platform

5. the name and address of the manufacturer;

6. the name, address, telephone and fax numbers and e-mail address of the responsible testing laboratory;

7. the model name(s) of the vehicles included in the test plan;

8. where appropriate, the list of vehicle types covered within the manufacturer's information, i.e. for tailpipe emissions, the in-service family;

9. the numbers of the type approvals applicable to these vehicle types within the family, including, where applicable, the numbers of all extensions and field fixes/recalls (re-works);

10. details of extensions, field fixes/recalls to those type approvals for the vehicles covered within the manufacturer's information (if requested by the approval authority);

11. the period of time over which the information was collected;

12. the ISC checking procedure, including where applicable:

    (i) vehicle sourcing method;

    (ii) vehicle selection and rejection criteria (including the answers to the table in Appendix 1, including photos);

    (iii) test types and procedures used for the programme;

    (iv) geographical area(s) within which the manufacturer has collected information;

    (v) sample lot number and sampling plan used;

13. the results of the ISC procedure, including:

    (i) identification of the vehicles included in the programme (whether tested or not). The identification shall include the Table in Appendix 1 without the confidential items.

    (ii) test data for tailpipe emissions:

    — test fuel specifications (e.g. test reference fuel or market fuel),

    — test conditions (temperature, humidity, dynamometer inertia weight),

    — dynamometer settings (e.g. road load, power setting),

    — test results and calculation of pass/fail;

(iii) test data for evaporative emissions:

— test fuel specifications (e.g. test reference fuel or market fuel),

— test conditions (temperature, humidity, dynamometer inertia weight),

— dynamometer settings (e.g. road load, power setting),

— test results and calculation of pass/fail.

Appendix 4

Annual ISC Report by the granting type approval authority

TITLE

A. Quick overview and main conclusions

B. ISC activities performed by the manufacturer in the previous year:

(1) Information gathering by manufacturer

(2) ISC testing (including planning and selection of families tested, and final results of tests)

C. ISC activities performed by the other actors in the previous year:

(3) Information gathering and risk assessment

(4) ISC testing (including planning and selection of families tested, and final results of tests)

D. ISC activities performed by the granting type approval authority in the previous year:

(5) Information gathering and risk assessment

(6) ISC testing (including planning and selection of families tested, and final results of tests)

(7) Detailed investigations

(8) Remedial measures

E. Assessment of the yearly expected emissions decrease due to any ISC remedial measures

F. Lessons Learned (including for performance of instruments used)

G. Report of other invalid tests

Appendix 5

Transparency Lists

Table 1

Transparency List 1

ID	Input	Type of data	Unit	Description
1	**Emission TA number**	Text	- -	As reported in Annex I/Appendix 6 (Reg. (EU) 2017/1151)
1a	**Emission Type Approval Date**	Date	- -	Date of emission type-
2	**Interpolation Family ID (IP ID)**	Text	- -	As reported in Annex I, Appendix 4, Section II, Point 0. (Reg. (EU) 2017/1151) and in UNECE Regulation 154, Annex A2, Addendum to type approval communication item 0.1: Interpolation Family Identifier as defined in paragraph 6.2.2 of the same regulation
5	**ATCT family ID**	Text	- -	As reported in Annex I, Appendix 3, point 0.2.3.2. (Reg. (EU) 2017/1151)
7	**RL family ID of vehicle H or RM family ID**	Text	- -	As reported in Annex I, Appendix 3, point 0.2.3.4.1. (for Road Load Matrix Family point 0.2.3.5.) (Reg. (EU) 2017/1151)
7a	**RL family ID of vehicle L (if relevant)**	Text	- -	As reported in Annex I, Appendix 3, point 0.2.3.4.2. (Reg. (EU) 2017/1151)

ID	Input	Type of data	Unit	Description
7b	**RL family ID of vehicle M (if relevant)**	Text	- -	As reported in UNECE Regulation 154, Annex A1 - Appendix 1, point 1.4.2. Road load parameters
13	**Drive wheels of vehicle in family**	Enumeration (Front, Rear, 4 Wheel Drive)	- -	Annex I, Addendum to Appendix 4, point 1.7 (Reg. (EU) 2017/1151)
14	**Chassis Dyno configuration during TA test**	Enumeration (Single Axle, Dual Axle)	- -	As in UNECE Regulation 154, Annex B6; point 2.4.2.4.
18	**Driver selectable mode(s) used during the TA tests (pure ICE) or for charge sustaining test (NOVC-HEV, OVC-HEV, NOVC-FCHV)**	Possible formats: pdf, jpg. The name of the file shall be a UUID, unique inside the package.	- -	State and describe mode(s) used in type approval. In cases of predominant mode this will be only one entry. Alternatively the best and worst case modes need to be described. Description of modes that need to be used for TA tests As in UNECE Regulation 154, Annex B6; point 2.6.6.
19	**Driver selectable mode(s) used during the TA tests for charge depleting test (OVC-HEV)**	Possible formats: pdf, jpg. The name of the file shall be a UUID, unique inside the package.	- -	State and describe mode(s) used in type approval. In cases of predominant mode this will be only one entry. Alternatively the best and worst case modes need to be described. Description of modes that need to be used for TA tests As in UNECE Regulation 154, Annex B8 point 3.2.3
20	**Idling engine speed for vehicles with manual transmission fuel 1, fuel 2 (if relevant)**	Number	rpm	Annex I, Appendix 3, point 3.2.1.6. (Reg. (EU) 2017/1151)
21	**No. of gears for vehicles with manual transmission**	Number	- -	Annex I, Addendum to Appendix 4, point 1.13.2. (Reg. (EU) 2017/1151)

ID	Input	Type of data	Unit	Description
23	**Tyre dimensions of the test vehicle front/rear/middle, for vehicles with manual transmission**	Text	- -	Annex I, Appendix 8a point 1.1.8 (Reg. (EU) 2017/1151) Use 1 for tyre dimensions of front wheels, 2 for tyre dimensions of rear wheels, 3 for tyre dimensions of middle wheels (if applicable)
24 + **25**	**Full load power curve with additional safety margin (ASM) for vehicles with manual transmission, fuel 1, fuel 2 (if relevant)**	Table values	rpm vs. kW vs. %	The full load power curve over the engine speed range from n_{idle} to n_{rated} or n_{max}, or ndv (ngv_{max}) × v_{max}, whichever is higher together with ASM (if used for gearshift calculation) from Annex I, Appendix 8a, point 1.2.4. (Reg. (EU) 2017/1151) Example of table values can be found in Example of table values can be found in UNECE Regulation 154, Annex B2, Table A2/1
26	**Additional information for gearshift calculation for vehicles with manual transmission, fuel 1, fuel 2 (if relevant)**	See table in example	See table in example	Annex I, Appendix 8a, point 1.2.4. (Reg. (EU) 2017/1151)
29	**ATCT FCF fuel 1, fuel 2 (if relevant)**	Number	- -	One value per each fuel in case of Bi-fuel and Flex-fuel vehicle. Always match Fuel 1 with its ATCT FCF and Fuel 2 with its ATCT FCF. As defined in UNECE Regulation 154, Annex B6a, point 3.8.1.
30a	**Additive Ki factor(s) for vehicles equipped with periodically regenerating systems**	Table values	g/km for CO_2, mg/km for all the rest	Table defining the values for CO, NO_x, PM, THC (mg/km), and for CO_2 (g/km). Empty if multiplicative Ki factors are provided or for vehicles that don't have any periodically regenerating systems. Annex I, Appendix 8a, point 2.1.1.1.1. for pollutants and point 2.1.1.2.1. for CO_2. (Reg. (EU) 2017/1151)

ID	Input	Type of data	Unit	Description
30b	**Multiplicative Ki factors(s) for vehicles equipped with periodically regenerating systems**	Table values	no units	Table defining the values for CO, NO_x, PM, THC, and for CO_2. Empty if additive Ki factors are provided or for vehicles that don't have any periodically regenerating systems.. Annex I, Appendix 8a, point 2.1.1.1.1. for pollutants and point 2.1.1.2.1. for CO_2 (Reg. (EU) 2017/1151)
31a	**Additive Deterioration Factors (DF) fuel 1, fuel 2 (if relevant)**	Table values	(mg/km except for PN which is #/km	Table defining deterioration factors per each pollutant. (1) CO, PM, PN, NO_x, NMHC and THC for monofuel gasoline vehicles and all bi-fuel and flexifuel vehicles. (2) CO, NO_x, NMHC and THC for monofuel LPG and NG vehicles. (3) NO_x for monofuel H_2 vehicles. (4) NO_x, THC+NO_X, CO, PM and PN for all diesel vehicles. (5) Empty if multiplicative DF factors are provided. Annex I, Appendix 8a, point 2.1.1.1.1. (Reg. (EU) 2017/1151).
31b	**Multiplicative Deterioration Factors (DF) fuel 1, fuel 2 (if relevant)**	Table values	no units	Table defining deterioration factors per each pollutant. — CO, PM, PN, NO_x, NMHC and THC for monofuel gasoline vehicles and all bi-fuel and flexifuel vehicles. — CO, NO_x, NMHC and THC for monofuel LPG and NG vehicles. — NO_x for monofuel H_2 vehicles. — NO_x, THC+NO_x, CO, PM and PN for all diesel vehicles. Empty if additive DF factors are provided. Annex I, Appendix 8a, point 2.1.1.1.1. (Reg. (EU) 2017/1151).
32	**Battery voltage for all REESS**	Number	V	As defined in UNECE Regulation 154 Annex B6 - Appendix 2 point 4.1 (DIN EN 60050-482)

ID	Input	Type of data	Unit	Description
33	**K correction coefficient only** for NOVC and OVC-HEVs	Table	(g/km)/ (Wh/km)	For NOVC and OVC-HEVs correction of CS CO_2 emissions as defined in UNECE Regulation 154 Annex B8, appendix 2, point 2
42	Regeneration recognition	Document pdf or jpg The name of the file shall be a UUID, unique inside the package.		Description by vehicle manufacturer on how to recognize that a regeneration occurred during a test
43	Regeneration completion	Document pdf or jpg The name of the file shall be a UUID, unique inside the package.	—	Description of the procedure to complete the regeneration
44a	Index Number of the transition cycle for VL	number	—	For OVC-HEV vehicles only. Number of CD tests performed until break-off criteria is met. Annex I, Appendix 8a, point 2.1.1.4.1.4. (Regulation (EU) 2017/1151)
	For multistage or multistage special purpose vehicles			
45	Allowed final Vehicle mass in running order	Number	Kg	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to
45a	Allowed final Vehicle actual mass	Number	kg	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to
45b	Allowed Vehicle technically permissible maximum laden mass (in kg)	Number	kg	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to
46	Allowed frontal area for final vehicle	Number	cm^2	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to

ID	Input	Type of data	Unit	Description
47	Allowed Rolling resistance	Number	kg/t	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to
48	Allowed projected frontal area of air entrance of the front grille	Number	cm^2	As reported in point 0.2.2.1 in Annex I of Regulation (EU) 2020/683 From-to
	FOR ALL VEHICLES			
49	**Propulsion Type**	Enumeration Pure ICE, OVC-HEV, NOVC-HEV	- -	Propulsion type as defined in ANNEX IIIA, point 3.3.1.2 (a)
50	**Ignition Type**	Enumeration Positive ignition, Compression ignition	- -	Ignition Type as reported in point 3.2.1.1. Appendix 3 of Annex I (Reg. (EU) 2017/1151)
51	**Fuel Operating Mode**	Enumeration (Mono-fuel, Bi-fuel, Flex-fuel)	- -	Vehicle Fuel Type as reported in point 3.2.2.4. Appendix 3 of Annex I (Reg. (EU) 2017/1151)
52	**Fuel Type fuel 1, fuel 2 (if relevant)**	Enumeration (Petrol, Diesel, LPG, NG/Biomethane, Ethanol (E85), Hydrogen).	- -	Fuel Type as reported in point 3.2.2.1. Appendix 3 of Annex I (Reg. (EU) 2017/1151). In the case of Bi-fuel and Flex-fuel vehicle list both fuels.
53	**Transmission type**	Enumeration (Manual, Automatic, CVT)	- -	Transmission Type as reported in point 4.5.1. Appendix 3 of Annex I (Reg. (EU) 2017/1151)
54	**Engine Capacity**	Number	cm^3	Engine Capacity as reported in point 3.2.1.3. Appendix 3 of Annex I (Reg. (EU) 2017/1151).
55	**Method of engine fuelling fuel 1, fuel 2 (if relevant)**	Enumeration Direct/Indirect/ Direct and Indirect		Method of engine fuelling as declared by OEM. point 1.10.2 of Addendum to Appendix 4 of Annex I (Reg. (EU) 2017/1151

Table 2

Transparency list 2

Field	Type of data	Description
TVV	Text	Unique identifier of the Type, Variant, Version of the vehicle point 7.3 and 7.4 of Part B of Annex I (Regulation (EU) 2018/858)
PEMS Family ID	Text	Annex IIIA, point 3.5.2.
Make	Text	Trade name of manufacturer point 0.1 Annex I (Regulation (EU) 2020/683)
Commercial name	Text	Commercial names of the TVV point 0.2.1 Annex I (Regulation (EU) 2020/683)
Other name	Text	Free text
Category and class	Enumeration (M1, N1 class I, N1 class II, N1 class III, N2, N3, M2, M3)	Category and class of vehicle 715/2007 Annex I (Class) 2018/858 Annex I (Categories)
Bodywork	Enumeration (AA Saloon; AB Hatchback, AC Station Wagon, AD Coupe, AE Convertible, AF Multi-purpose vehicle AG Truck station wagon BA Lorry, BB Van, BC Tractor unit for semi-trailer BD Road tractor BE Pick-up track BX Chassis-cab or chassis-cowl)	Type of bodywork 0.3.0.2 Annex I (Regulation (EU) 2020/683)
Emission TA Number	Text	Annex IV of Regulation (EU) 2020/683

Field	Type of data	Description
WVTA Number	Text	Identifier of the Whole Vehicle Type-Approval as defined in Annex IV of Regulation (EU) 2020/683
Evap family ID	Text	As reported in Annex I, Appendix 3, point 0.2.3.7. (Reg. (EU) 2017/1151)
Rated Engine Power fuel 1, fuel 2 (if relevant)	Number	Annex I, Appendix 3, point 3.2.1.8. (Reg. (EU) 2017/1151)
Twin tires	Yes/No	Declared by OEM
Fuel Tank Capacities (discreet values)	Number	Fuel tank(s) capacity(ies) point 3.2.3.1.1 of Annex I (Regulation (EU) 2020/683)
Sealed tank	Yes/No	3.2.12.2.5.5.3 of Annex I (Regulation (EU) 2020/683)
WMI used in this WVTA+TVV	Text	Declared by the OEM (ISO 3779)’

ANNEX III

'ANNEX IIIA

1. ABBREVIATIONS

Abbreviations refer generically to both the singular and the plural forms of abbreviated terms.

CLD	—	ChemiLuminescence Detector
CVS	—	Constant Volume Sampler
DCT	—	Dual Clutch Transmission
ECU	—	Engine Control Unit
EFM	—	Exhaust mass Flow Meter
FID	—	Flame Ionisation Detector
FS	—	full scale
GNSS	—	Global Navigation Satellite System
HCLD	—	Heated ChemiLuminescence Detector
ICE	—	Internal Combustion Engine
LPG	—	Liquid Petroleum Gas
NDIR	—	Non-Dispersive InfraRed analyser
NDUV	—	Non-Dispersive UltraViolet analyser
NG	—	Natural Gas
NMC	—	Non-Methane Cutter
NMC-FID	—	Non-Methane Cutter in combination with a Flame-Ionisation Detector
NMHC	—	Non-Methane HydroCarbons
OBD	—	On-Board Diagnostics
PEMS	—	Portable Emissions Measurement System
RPA	—	Relative Positive Acceleration
SEE	—	Standard Error of Estimate
THC	—	Total HydroCarbons
VIN	—	Vehicle Identification Number
WLTC	—	Worldwide harmonized Light vehicles Test Cycle

2. DEFINITIONS

2.1. **For the purposes of this Annex, the following definitions shall apply in terms of generic issues**:

2.1.1. "Vehicle type with regard to Real Driving Emissions" means a group of vehicles which do not differ with respect to the criteria constituting a "PEMS test family" as defined in point 3.3.1.

2.1.2. "Declared Maximum RDE" means the emission values, which must necessarily be lower than the applicable emission limits, declared optionally by the manufacturer and used for checking compliance against lower emission limits

2.2. **For the purposes of this Annex, the following definitions shall apply in terms of test equipment**:

2.2.1. "Accuracy" means the difference between a measured value and a reference value, traceable to a national or international standard and describes the correctness of a result (Figure 1).

2.2.2. "Adapter" means in the context of this annex mechanical parts that allow the connection of the vehicle to a commonly used or standardized measurement device connector.

2.2.3. "Analyser" means any measurement device that is not part of the vehicle but installed to determine the concentration or the amount of gaseous or particle pollutants.

2.2.4. "Calibration" means the process of setting a measurement system's response so that its output agrees with a range of reference signals.

2.2.5. "Calibration gas" means a gas mixture used to calibrate gas analysers.

2.2.6. "Delay time" means the difference in time between the change of the component to be measured at the reference point and a system response of 10 per cent of the final reading (t10) with the sampling probe being defined as the reference point (Figure 2).

2.2.7. "Full scale" means the full range of an analyser, flow-measuring instrument or sensor as specified by the equipment manufacturer or the highest range used for the specific test.

2.2.8. "Hydrocarbon response factor" of a particular hydrocarbon species means the ratio between the reading of a FID and the concentration of the hydrocarbon species under consideration in the reference gas cylinder, expressed as $ppmC_1$.

2.2.9. "Major maintenance" means the adjustment, repair or replacement of a component or module that could affect the accuracy of a measurement.

2.2.10. "Noise" means two times the root mean square of ten standard deviations, each calculated from the zero responses measured at a constant frequency which is a multiple of 1,0 Hz during a period of 30 seconds.

2.2.11. "Non-methane hydrocarbons" (NMHC) means the Total Hydrocarbons (THC) minus the methane (CH_4) contribution.

2.2.12. "Precision" means the degree to which repeated measurements under unchanged conditions show the same results (Figure 1).

2.2.13. "Reading" means the numerical value displayed by an analyser, flow-measuring instrument, sensor or any other measurement devise applied in the context of vehicle emission measurements.

2.2.14. "Reference value" means a value traceable to a national or international standard (Figure 1).

2.2.15. “Response time” (t90) means the difference in time between the change of the component to be measured at the reference point and a system response of 90 per cent of the final reading (t90) with the sampling probe being defined as the reference point, whereby the change of the measured component is at least 60 per cent full scale (FS) and takes place in less than 0.1 second. The system response time consists of the delay time to the system and of the rise time of the system as depicted in Figure 2.

2.2.16. “Rise time” means the difference in time between the 10 per cent and 90 per cent response of the final reading (t10 to t90) as depicted in Figure 2.

2.2.17. “Sensor” means any measurement device that is not part of the vehicle itself but installed to determine parameters other than the concentration of gaseous and particle pollutants and the exhaust mass flow.

2.2.18. “Set point” means the target value a control system aims to reach.

2.2.19. “Span” means to adjust an instrument so that it gives a proper response to a calibration standard that represents between 75 per cent and 100 per cent of the maximum value in the instrument range or expected range of use.

2.2.20. “Span response” means the mean response to a span signal over a time interval of at least 30 seconds.

2.2.21. “Span response drift” means the difference between the mean response to a span signal and the actual span signal that is measured over a defined time period after an analyser, flow-measuring instrument or sensor has been accurately spanned.

2.2.22. “Total hydrocarbons” (THC) means the sum of all volatile compounds measurable by a flame ionization detector (FID).

2.2.23. “Traceable” means the ability to relate a measurement or reading through an unbroken chain of comparisons to a national or international standard.

2.2.24. “Transformation time” means the time difference between a change of concentration or flow (t0) at the reference point and a system response of 50 per cent of the final reading (t50) as depicted in Figure 2.

2.2.25. “Type of analyser”, also referred to as “analyser type” means a group of analysers produced by the same manufacturer that apply an identical principle to determine the concentration of one specific gaseous component or the number of particles.

2.2.26. “Type of exhaust mass flow meter” means a group of exhaust mass flow meters produced by the same manufacturer that share a similar tube inner diameter and function on an identical principle to determine the mass flow rate of the exhaust gas.

2.2.27. “Verification” means the process of evaluating whether the measured or calculated output of an analyser, flow-measuring instrument, sensor or signal or method agrees with a reference signal or value within one or more predetermined thresholds for acceptance.

2.2.28. “Zero” means the calibration of an analyser, flow-measuring instrument or sensor so that it gives an accurate response to a zero signal.

2.2.29. "Zero gas" means a gas containing no analyte, which is used to set a zero response on an analyser.

2.2.30. "Zero response" means the mean response to a zero signal over a time interval of at least 30 seconds.

2.2.31. "Zero response drift" means the difference between the mean response to a zero signal and the actual zero signal that is measured over a defined time period after an analyser, flow-measuring instrument or sensor has been accurately zero calibrated.

Figure 1

Definition of accuracy, precision and reference value

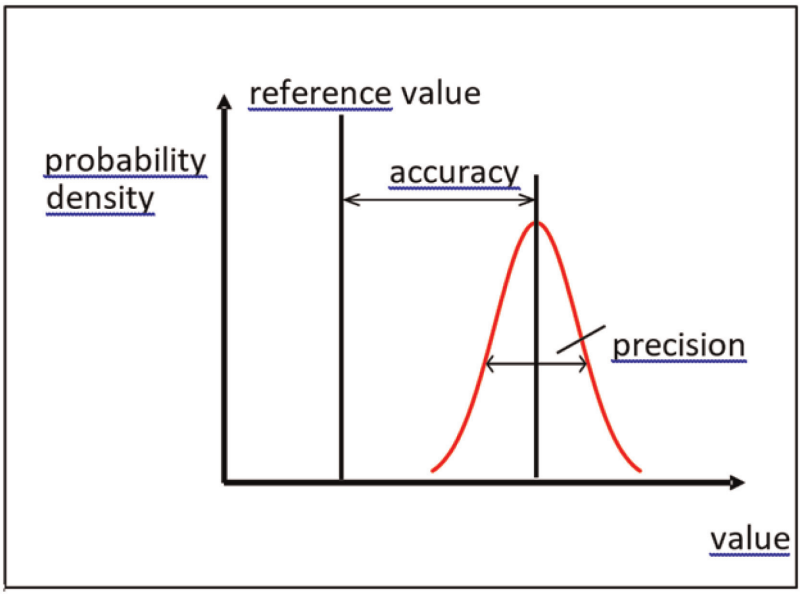
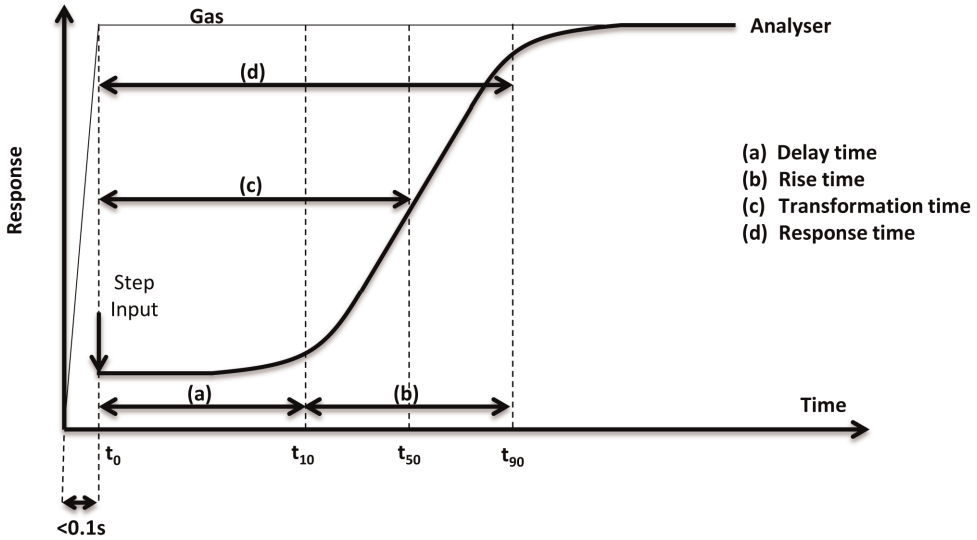


Figure 2

Definition of delay, rise, transformation and response times



2.3. **For the purposes of this Annex, the following definitions shall apply in terms of vehicle characteristics and driver**:

2.3.1. "Actual mass of the vehicle" means the mass in running order plus the mass of the fitted optional equipment to an individual vehicle.

2.3.2. "Auxiliary devices" means energy consuming, converting, storing or supplying non-peripheral devices or systems which are installed in the vehicle for purposes other than the propulsion of the vehicle and are therefore not considered to be part of the powertrain.

2.3.3. "Mass in running order" means the mass of the vehicle, with its fuel tank(s) filled to at least 90 per cent of its or their capacity/capacities, including the mass of the driver, fuel and liquids, fitted with the standard equipment in accordance with the manufacturer's specifications and, when they are fitted, the mass of the bodywork, the cabin, the coupling and the spare wheel(s) as well as the tools.

2.3.4. "Maximum Permissible Test mass of the vehicle" means the sum of the actual mass of the vehicle and 90 per cent of the difference between the technically permissible maximum laden mass and the actual mass of the vehicle (Figure 3).

2.3.5. "Odometer" means an instrument indicating to the driver the total distance driven by the vehicle since its production.

2.3.6. "Optional equipment" means all the features not included in the standard equipment which are fitted to a vehicle under the responsibility of the manufacturer, and that can be ordered by the customer.

2.3.7. "Power-to-test mass-ratio" corresponds to the ratio of the rated engine power of the internal combustion engine over the test mass (i.e. the actual mass of the vehicle plus the mass of the measurement equipment and the mass of additional passengers or payload, if any).

2.3.8. "Power-to-mass-ratio" is the ratio of rated power to the mass in running order.

2.3.9. "Rated engine power (Prated)" means maximum net power of the engine or motor in kW as per the requirements of UN Regulation No 85 ([1]).

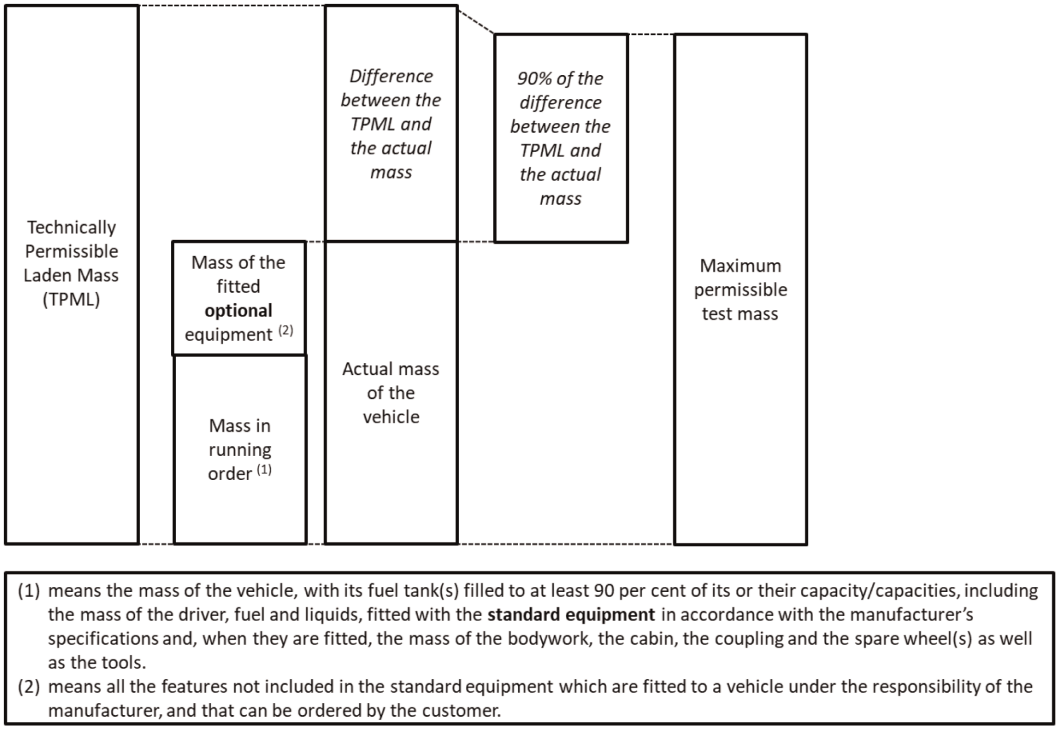
2.3.10. "Technically permissible maximum laden mass" means the maximum mass allocated to a vehicle on the basis of its construction features and its design performances.

2.3.11. "Vehicle OBD information" means information relating to an on-board diagnostic system for any electronic system on the vehicle

([1]) Regulation No 85 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of internal combustion engines or electric drive trains intended for the propulsion of motor vehicles of categories M and N with regard to the measurement of net power and the maximum 30 minutes power of electric drive trains (OJ L 323, 7.11.2014, p. 52).

Figure 3

Mass definitions



2.3.12. "Flex fuel vehicle" means a vehicle with one fuel storage system that can run on different mixtures of two or more fuels.

2.3.13. "Mono-fuel vehicle" means a vehicle that is designed to run primarily on one type of fuel.

2.3.14. "Not off-vehicle charging hybrid electric vehicle" (NOVC-HEV) means a hybrid electric vehicle that cannot be charged from an external source.

2.3.15. "Off-vehicle charging hybrid electric vehicle" (OVC-HEV) means a hybrid electric vehicle that can be charged from an external source.

2.4. **For the purposes of this Annex, the following definitions shall apply in terms of Calculations**

2.4.1. "Coefficient of determination" (r^2) means:

$$r^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - a_0 - (a_1 \times x_i))^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

where:

a_0 is the axis intercept of the linear regression line

a_1 is the slope of the linear regression line

x_i is the measured reference value

y_i is the measured value of the parameter to be verified

$\bar{y}$ is the mean value of the parameter to be verified

n is the number of values

2.4.2. *"Cross-correlation coefficient" (r) means:*

$$r = \frac{\sum_{i=1}^{n-1}(x_i - \overline{x}) \times (y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n-1}(x_i - \overline{x})^2} \times \sqrt{\sum_{i=1}^{n-1}(y_i - \overline{y})^2}}$$

where:

x_i is the measured reference value

y_i is the measured value of the parameter to be verified

$\overline{x}$ is the mean reference value

$\overline{y}$ is the mean value of the parameter to be verified

n is the number of values

2.4.3. *"Root mean square" (x_{rms}) means the square root of the arithmetic mean of the squares of values and defined as:*

$$x_{rms} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2}$$

where:

x_i is the measured or calculated value

n is the number of values

2.4.4. *"Slope" of a linear regression (a_1) means:*

$$a_1 = \frac{\sum_{i=1}^{n}(x_i - \overline{x}) \times (y_i - \overline{y})}{\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

where:

x_i is the actual value of the reference parameter

y_i is the actual value of the parameter to be verified

$\overline{x}$ is the mean value of the reference parameter

$\overline{y}$ is the mean value of the parameter to be verified

n is the number of values

2.4.5. *"Standard error of estimate" (SEE) means:*

$$SEE = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \acute{y})^2}{n-2}}$$

where:

$\acute{y}$ is the estimated value of the parameter to be verified

y_i is the actual value of the parameter to be verified

n is the number of values

2.5. **For the purposes of this Annex, the following definitions shall apply in terms of other items**

2.5.1. "Cold start period" means the period from the test start as defined in point 2.6.5 until the point when the vehicle has run for 5 minutes. If the coolant temperature is determined, the cold start period ends once the coolant is at least 70 °C for the first time but no later than 5 minutes after test start. In the case that measuring the coolant temperature is not feasible, on request of the manufacturer and with approval of the approval authority, instead of using the coolant temperature, the engine oil temperature may be used.

2.5.2. "Deactivated internal combustion engine" means an internal combustion engine for which one of the following criteria apply:

— the recorded engine speed is < 50 rpm;

— or when the engine speed is not recorded, the exhaust mass flow rate is measured at < 3 kg/h.

2.5.3. "Engine control unit" means the electronic unit that controls various actuators to ensure the optimal performance of the engine.

2.5.4. "Extended factor" means a factor which accounts for the effect of extended ambient temperature or altitude conditions upon pollutant emissions.

2.5.5. *"Particle number emissions" (PN) means the total number of solid particles* [2] *emitted from the vehicle exhaust quantified according to the dilution, sampling and measurement methods as specified in this Annex.*

2.6. **For the purposes of this Annex, the following definitions shall apply in terms of Testing Procedure**

2.6.1. *"Cold start PEMS trip" means a trip with conditioning of the vehicle prior to the test as described in paragraph 5.3.2.*

2.6.2. *"Hot start PEMS trip" means a trip without conditioning of the vehicle prior to the test as described in paragraph 5.3.2, but with a warm engine with coolant temperature above 70 °C. In the case that measuring the coolant temperature is not feasible, on request of the manufacturer and with approval of the approval authority, instead of using the coolant temperature, the engine oil temperature may be used.*

2.6.3. *"Periodically regenerating system" means a pollutant emissions control device (e.g. catalytic converter, particulate trap) that requires a periodical regeneration*

2.6.4. *"Reagent" means any product other than fuel that is stored on-board the vehicle and is provided to the exhaust after-treatment system upon request of the emission control system.*

2.6.5. *"Test start" means (Figure 4) whichever occurs first from*:

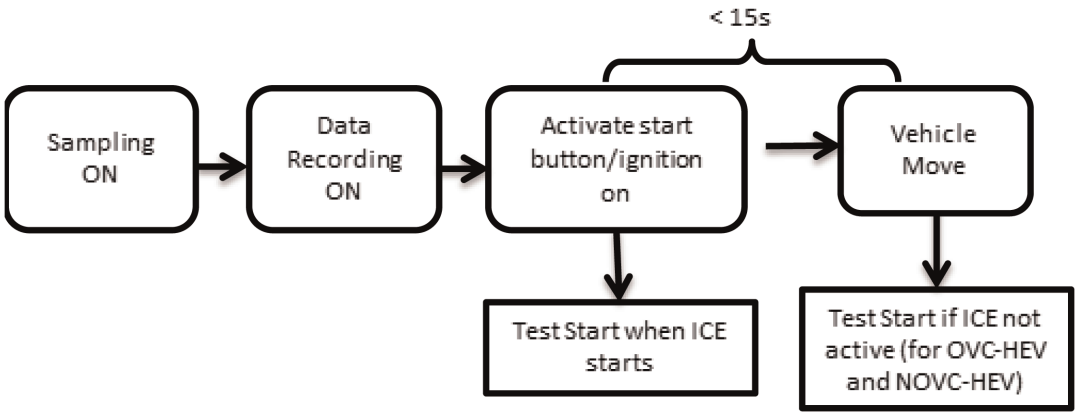
— the first activation of the internal combustion engine;

— the first movement of the vehicle with speed greater than 1 km/h for OVC-HEVs and NOVC-HEVs.

[2] The term "*particle*" is conventionally used for the matter being characterised (measured) in the airborne phase (suspended matter), and the term "particulate" for the deposited matter.

Figure 4

Test start definition



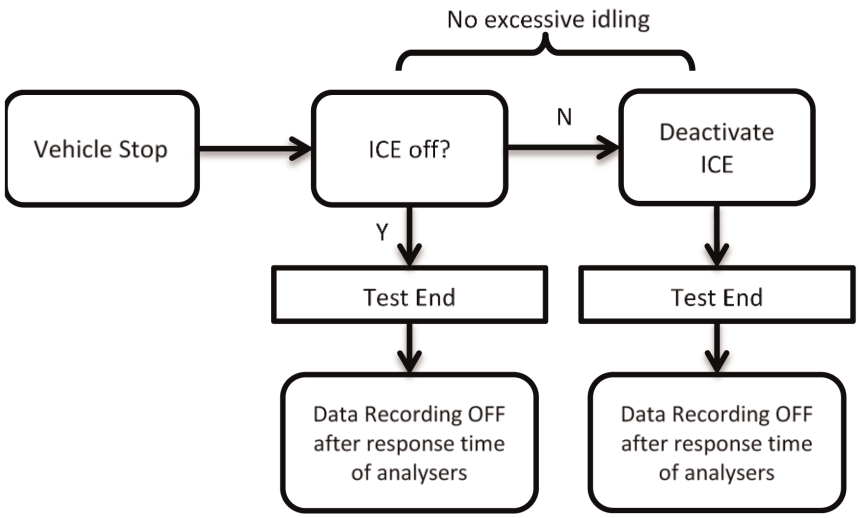
2.6.6. *"Test end" means (Figure 5) that the vehicle has completed the trip and whichever occurs last from:*

— the final deactivation of the internal combustion engine;

— the vehicle stops and the speed is lower than or equal to 1 km/h for OVC-HEVs and NOVC-HEVS finishing the test with deactivated internal combustion engine.

Figure 5

Test end definition



2.6.7. *"Validation of PEMS" means the process of evaluating on a chassis dynamometer the correct installation and functionality within the given accuracy limits of a Portable Emissions Measurement System and exhaust mass flow rate measurements as obtained from one or multiple non-traceable exhaust mass flow meters or as calculated from sensors or ECU signals.*

3. GENERAL REQUIREMENTS

3.1. **Compliance requirements**

For vehicle types approved according to this Annex, the final RDE emission results calculated according to this Annex at any possible RDE test performed in accordance with the requirements of this Annex, shall not be higher than any of the relevant Euro 6 emission limits laid down in Table 2 of Annex I to Regulation (EC) No 715/2007. The manufacturer shall confirm compliance with this Regulation by completing the RDE compliance certificate set out in Appendix 12.

The manufacturer may declare compliance with lower emission limits by declaring lower values called "Declared Maximum RDE", either for NOx or PN or both, in the Manufacturer's RDE certificate of compliance found in Appendix 12 and the Certificate of Conformity of each vehicle. These Declared Maximum RDE values shall be used for checking the compliance of cars when applicable, including for tests performed during In-service Conformity and Market Surveillance.

The RDE performance shall be demonstrated by performing the necessary tests in the PEMS test family on the road operated over their normal driving patterns, conditions and payloads. The necessary tests shall be representative for vehicles operated on their real driving routes, with their normal load. The requirements of emission limits shall be fulfilled for the urban operation and the complete PEMS trip.

The RDE tests required by this Annex provide a presumption of conformity. The presumed conformity may be reassessed by additional RDE tests. Verification of compliance shall be made in accordance with the rules of in-service conformity.

3.2. **Facilitation of PEMS testing**

Member States shall ensure that vehicles can be tested with PEMS on public roads in accordance with the procedures under their own national law, while respecting local road traffic legislation and safety requirements.

Manufacturers shall ensure that vehicles can be tested with PEMS. This shall include:

(a) constructing the exhaust pipes in order to facilitate sampling of the exhaust, or making available suitable adapters for exhaust pipes for testing by the authorities;

(b) in case the exhaust pipe construction does not facilitate sampling of the exhaust, the manufacturer shall also make available to independent parties, adapters for purchase or rent via their spare parts or service tools network (e.g. RMI portal), through authorised dealers or via a contact point on the referred publicly accessible website;

(c) providing guidance available online, without the need of registration or login, on how to attach a PEMS to vehicles;

(d) granting access to ECU signals relevant to this Annex, as mentioned in Table A4/1 of Appendix 4; and

(e) making the necessary administrative arrangements.

3.3. **Selection of vehicles for PEMS testing**

PEMS tests shall not be required for each *"vehicle type with regards to Real Driving Emissions"*. Several vehicle emission types may be put together by the vehicle manufacturer to form a "*PEMS test family*" in accordance with the requirements of paragraph 3.3.1., which shall be validated in accordance with the requirements of paragraph 3.4.

Symbols, parameters and units

N	—	Number of vehicle emission types
NT	—	Minimum number of vehicle emission types
PMR_H	—	highest power-to-mass-ratio of all vehicles in the PEMS test family
PMR_L	—	lowest power-to-mass-ratio of all vehicles in the PEMS test family
V_eng_max	—	maximum engine volume of all vehicles within the PEMS test family

3.3.1. *PEMS test family building*

A PEMS test family shall comprise finished vehicles of a manufacturer with similar emission characteristics. Vehicle emission types may be included in a PEMS test family only as long as the vehicles within a PEMS test family are identical with respect to the characteristics in all the administrative and technical criteria listed below.

3.3.1.1. Administrative criteria

(a) The approval authority issuing the emission type approval in accordance with this Annex ('authority')

(b) The manufacturer having received the emission type approval in accordance with this Annex ('manufacturer').

3.3.1.2. Technical criteria

(a) Propulsion type (e.g. ICE, NOVC-HEV, OVC-HEV)

(b) Type(s) of fuel(s) (e.g. petrol, diesel, LPG, NG, …). Bi- or flex-fuelled vehicles may be grouped with other vehicles, with which they have one of the fuels in common.

(c) Combustion process (e.g. two stroke, four stroke)

(d) Number of cylinders

(e) Configuration of the cylinder block (e.g. in-line, V, radial, horizontally opposed, …)

(f) Engine volume

The vehicle manufacturer shall specify a value V_eng_max (= maximum engine volume of all vehicles within the PEMS test family). The engine volumes of vehicles in the PEMS test family shall not deviate more than − 22 % from V_eng_max if V_eng_max ≥ 1500 ccm and − 32 % from V_eng_max if V_eng_max < 1500 ccm.

(g) Method of engine fuelling (e.g. indirect or direct or combined injection)

(h) Type of cooling system (e.g. air, water, oil)

(i) Method of aspiration such as naturally aspirated, pressure charged, type of pressure charger (e.g. externally driven, single or multiple turbo, variable geometries …)

(j) Types and sequence of exhaust after-treatment components (e.g. three-way catalyst, oxidation catalyst, lean NOx trap, SCR, lean NOx catalyst, particulate trap)

(k) Exhaust gas recirculation (with or without, internal/external, cooled/non-cooled, low/high pressure)

3.3.1.3. **Extension of a PEMS test family**

An existing PEMS test family may be extended by adding new vehicle emission types to it. The extended PEMS test family and its validation must also fulfil the requirements of paragraphs 3.3. and 3.4. This may require the PEMS testing of additional vehicles to validate the extended PEMS test family according to paragraph 3.4.

3.3.1.4. **Alternative PEMS test family definition**

As an alternative to the provisions of paragraph 3.3.1.1 and 3.3.1.2. the vehicle manufacturer may define a PEMS test family that is identical to a single vehicle emission type or a single WLTP IP-family. In this case, only one vehicle has to be tested from the family in either a hot or a cold test, at the choice of the authority and there is no need to validate the PEMS test family as in paragraph 3.4.

3.4. **Validation of a PEMS test family**

3.4.1. *General requirements for validating a PEMS test family*

3.4.1.1. The vehicle manufacturer shall present a representative vehicle of the PEMS test family to the authority. The vehicle shall be subject to a PEMS test carried out by a Technical Service to demonstrate compliance of the representative vehicle with the requirements of this Annex.

3.4.1.2. The authority shall select additional vehicles according to the requirements of paragraph 3.4.3. for PEMS testing carried out by a Technical Service to demonstrate compliance of the selected vehicles with the requirements of this Annex. The technical criteria for selection of an additional vehicle according to paragraph 3.4.3. shall be recorded with the test results.

3.4.1.3. With agreement of the authority, a PEMS test can also be driven by a different operator witnessed by a Technical Service, provided that at least the tests of the vehicles required by paragraphs 3.4.3.2. and 3.4.3.6. and in total at least 50 per cent of the PEMS tests required for validating the PEMS test family are driven by a Technical Service. In such case the Technical Service remains responsible for the proper execution of all PEMS tests pursuant to the requirements of this Annex.

3.4.1.4. A PEMS test result of a specific vehicle may be used for validating different PEMS test families under the following conditions:

— the vehicles included in all PEMS test families to be validated are approved by a single authority according to this Annex and this authority agrees to the use of the specific vehicle's PEMS test results for validating different PEMS test families;

— each PEMS test family to be validated includes a vehicle emission type, which comprises the specific vehicle.

3.4.2. For each validation, the applicable responsibilities are considered to be borne by the manufacturer of the vehicles in the respective family, regardless of whether this manufacturer was involved in the PEMS test of the specific vehicle emission type.

3.4.3. Selection of vehicles for PEMS testing when validating a PEMS test family

When selecting vehicles from a PEMS test family, it shall be ensured that the following technical characteristics relevant for pollutant emissions are covered by a PEMS test. A particular vehicle selected for testing can be representative for different technical characteristics. For the validation of a PEMS test family, vehicles shall be selected for PEMS testing as follows:

3.4.3.1. For each combination of fuels (e.g. petrol-LPG, petrol-NG, petrol only), on which some vehicles of the PEMS test family can operate, at least one vehicle that can operate on such combination of fuels shall be selected for PEMS testing.

3.4.3.2. The manufacturer shall specify a value PMR_H (= highest power-to- mass-ratio of all vehicles in the PEMS test family) and a value PMR_L (= lowest power-to- mass-ratio of all vehicles in the PEMS test family). At least one vehicle configuration representative for the specified PMR_H and one vehicle configuration representative for the specified PMR_L of a PEMS test family shall be selected for testing. The power-to- mass ratio of a vehicle shall not deviate by more than 5 per cent from the specified value for PMR_H, or PMR_L for the vehicle to be considered as representative for this value.

3.4.3.3. At least one vehicle for each transmission type (e.g., manual, automatic, DCT) installed in vehicles of the PEMS test family shall be selected for testing.

3.4.3.4. At least one vehicle per each configuration of driven axles shall be selected for testing if such vehicles are part of the PEMS test family.

3.4.3.5. For each engine volume associated with a vehicle in the PEMS test family at least one representative vehicle shall be tested.

3.4.3.6. At least one vehicle in the PEMS test family shall be tested in hot start testing.

3.4.3.7. Notwithstanding the provisions in paragraphs 3.4.3.1. to 3.4.3.6., at least the following number of vehicle emission types of a given PEMS test family shall be selected for testing:

Number of vehicle emission types in a PEMS test family (N)	Minimum number of vehicle emission types selected for PEMS cold start testing (NT)	Minimum number of vehicle emission types selected for PEMS hot start testing
1	1	1 ([2])
From 2 to 4	2	1
from 5 to 7	3	1
from 8 to 10	4	1
from 11 to 49	NT = 3 + 0,1 × N ([1])	2
more than 49	NT = 0,15 × N ([1])	3

([1]) NT shall be rounded to the next higher integer number
([2]) When there is only one vehicle emission type in a PEMS test family, the type approval authority shall decide whether the vehicle shall be tested in hot or cold start.

3.5. **Reporting for type approval**

3.5.1. The vehicle manufacturer shall provide a full description of the PEMS test family, which shall include the technical criteria described in paragraph 3.3.1.2. and submit it to the authority.

3.5.2. The manufacturer attributes a unique identification number of the format MS-OEM-X-Y to the PEMS test family and communicates it to the authority. Here MS is the distinguishing number of the Member State issuing the EC type-approval ([3]), OEM is the 3 character manufacturer, X is a sequential number identifying the original PEMS test family and Y is a counter for its extensions (starting with 0 for a PEMS test family not extended yet).

3.5.3. The authority and the vehicle manufacturer shall maintain a list of vehicle emission types being part of a given PEMS test family on the basis of emission type approval numbers. For each emission type all corresponding combinations of vehicle type approval numbers, types, variants and versions as defined in sections 0.10 and 0.2 of the vehicle's EC certificate of conformity shall be provided as well.

3.5.4. The authority and the vehicle manufacturer shall maintain a list of vehicle emission types selected for PEMS testing in order validate a PEMS test family in accordance with point 3.4, which also provides the necessary information on how the selection criteria of point 3.4.3 are covered. This list shall also indicate whether the provisions of point 3.4.1.3 were applied for a particular PEMS test.

3.6. **Rounding requirements:**

Rounding of data in the data exchange file, defined in Appendix 7, section 10, is not permitted. In the pre-processing file, the data may be rounded to the same order of magnitude of the accuracy of the measurement of a respective parameter.

The intermediate and final emission test results, as calculated in Appendix 11, shall be rounded in one step to the number of places to the right of the decimal point indicated by the applicable emission standard plus one additional significant figure. Preceding steps in the calculations shall not be rounded.

4. PERFORMANCE REQUIREMENTS FOR INSTRUMENTATION

The instrumentation used for RDE tests shall comply with the requirements in Appendix 5. If requested by the authorities, the tester shall provide proof that the instrumentation used complies with the requirements in Appendix 5.

5. TEST CONDITIONS

Only an RDE test fulfilling the requirements of this Section shall be accepted as valid. Tests performed outside the test conditions specified in this Section shall be considered as invalid, unless specified otherwise.

5.1. **Ambient conditions**

The test shall be conducted under the ambient conditions laid down in this section. The ambient conditions become 'extended' when at least one of the temperature or altitude conditions is extended. The factor for extended conditions as defined in paragraph 7.5. shall only be applied once even if both conditions are extended in the same time period. Notwithstanding the opening paragraph of this section, if a part of the test or the entire test is performed outside of extended conditions, the test shall be invalid only when final emissions as calculated in Appendix 11, are greater than the applicable emission limits. The conditions are as follows:

([3]) 1 for Germany; 2 for France; 3 for Italy; 4 for the Netherlands; 5 for Sweden; 6 for Belgium; 7 for Hungary; 8 for the Czech Republic; 9 for Spain; 12 for Austria; 13 for Luxembourg; 17 for Finland; 18 for Denmark; 19 for Romania; 20 for Poland; 21 for Portugal; 23 for Greece; 24 for Ireland. 25 for Croatia; 26 for Slovenia; 27 for Slovakia; 29 for Estonia; 32 for Latvia; 34 for Bulgaria; 36 for Lithuania; 49 for Cyprus; 50 for Malta.

For type approvals with character EA as in Table 1, Appendix 6 of Annex I:

Moderate altitude conditions:	Altitude lower or equal to 700 meters above sea level.
Extended altitude conditions:	Altitude higher than 700 meters above sea level and lower or equal to 1300 meters above sea level.
Moderate temperature conditions:	Greater than or equal to 273.15 K (0 °C) and lower than or equal to 303.15 K (30 °C).
Extended temperature conditions:	Greater than or equal to 266.15 K (– 7 °C) and lower than 273.15 K (0 °C) or greater than 303.15 K (30 °C) and lower than or equal to 308.15 K (35 °C).

For type approvals with character EB and EC as in Table 1, Appendix 6 of Annex I:

Moderate altitude conditions:	Altitude lower or equal to 700 meters above sea level.
Extended altitude conditions:	Altitude higher than 700 meters above sea level and lower or equal to 1300 meters above sea level.
Moderate temperature conditions:	Greater than or equal to 273.15 K (0 °C) and lower than or equal to 308.15 K (35 °C).
Extended temperature conditions:	Greater than or equal to 266.15 K (– 7 °C) and lower than 273.15 K (0 °C) or greater than 308.15 K (35 °C) and lower than or equal to 311.15 K (38 °C).

5.2. **Dynamic conditions of trip**

The dynamic conditions encompass the effect of road grade, head wind and driving dynamics (accelerations, decelerations) and auxiliary systems upon energy consumption and emissions of the test vehicle. The validity of the trip for the dynamic conditions shall be checked after the test is completed, using the recorded data. This verification shall be conducted in 2 steps:

STEP i: The excess or insufficiency of driving dynamics during the trip shall be checked using the methods described in Appendix 9.

STEP ii: If the trip is valid following the verifications in accordance with STEP i, the methods for verifying the validity of the trip as laid down in Appendices 8 and 10 shall be applied.

5.3. **Vehicle condition and operation**

5.3.1. *Vehicle condition*

The vehicle, including the emission related components, shall be in good mechanical condition and shall have been run in and driven at least 3 000 km before the test. The mileage and the age of the vehicle used for RDE testing shall be recorded.

All vehicles, and in particular OVC-HEVs vehicles may be tested in any selectable mode, including battery charge mode. On the basis of technical evidence provided by the manufacturer and with the agreement of the responsible authority, the dedicated driver-selectable modes for very special limited purposes shall not be considered (e.g. maintenance mode, race driving, crawler mode). All remaining modes used for driving may be considered and the pollutant emissions limits shall be fulfilled in all these modes.

Modifications that affect the vehicle aerodynamics are not permitted, with the exception of the PEMS installation. The tyre types and pressure shall be according to the vehicle's manufacturer recommendations. The tyre pressure shall be checked prior to the pre-conditioning and adjusted to the recommended values if needed. Driving the vehicle with snow chains is not permitted.

Vehicles should not be tested with an empty starter battery. In case the vehicle has problems starting, the battery shall be replaced following the recommendations of the vehicle's manufacturer.

The vehicle's test mass comprises of the driver, a witness of the test (if applicable), the test equipment, including the mounting and the power supply devices and any artificial payload. It shall be between the actual mass of the vehicle and the maximum permissible test mass of the vehicle at the beginning of the test and shall not increase during the test.

The test vehicles shall not be driven with the intention to generate a passed or failed test due to extreme driving that do not represent normal conditions of use. If necessary, verification of normal driving may be based on expert judgement made by or on behalf of the granting type approval authority through cross-correlation on several signals, which may include exhaust flow rate, exhaust temperature, CO_2, O_2 etc. in combination with vehicle speed, acceleration and GNSS data and potentially further vehicle data parameters like engine speed, gear, accelerator pedal position etc.

5.3.2. *Vehicle conditioning for cold start PEMS trip*

Before RDE testing, the vehicle shall be preconditioned in the following way:

The vehicle shall be driven on public roads, preferably on the same route as the planned RDE testing or for at least 10 min per type of operation (e.g. urban, rural, motorway) or 30 minutes with a minimum average velocity of 30 km/h. The validation test in the laboratory, as in Appendix 6 of this Annex, also counts as preconditioning. The vehicle shall subsequently be parked with doors and bonnet closed and kept in engine-off status within moderate or extended altitude and temperatures, in accordance with paragraph 5.1., for between 6 and 72 hours. Exposure to extreme atmospheric conditions (such as heavy snowfall, storm, hail) and excessive amounts of dust or smoke should be avoided.

Before the test start, the vehicle and equipment shall be checked for damages and the presence of warning signals that may suggest malfunctioning. In the case of a malfunction the source of the malfunctioning shall be identified and corrected or the vehicle shall be rejected.

5.3.3. *Auxiliary devices*

The air conditioning system or other auxiliary devices shall be operated in a way which corresponds to their typically intended use during real driving on the road. Any use shall be documented. The vehicle windows shall be closed when the air conditioning or heating are used.

5.3.4. *Vehicles equipped with periodically regenerating systems*

5.3.4.1. All results shall be corrected with the K_i factors or with the K_i offsets developed by the procedures in Appendix 1 to Annex B6 of the UN Regulation No 154 ([4]) for type-approval of a vehicle type with a periodically regenerating system. The K_i factor or the K_i offset shall be applied to the final results after evaluation in accordance with Appendix 11.

([4]) UN Regulation No 154 – Uniform provisions concerning the approval of light duty passenger and commercial vehicles with regards to criteria emissions, emissions of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range (WLTP) [2022/2124] (OJ L 290, 10.11.2022, p. 1).

5.3.4.2. If the final emissions as calculated in Appendix 11 are above the applicable emission limits, then the occurrence of regeneration shall be verified. The verification of a regeneration may be based on expert judgement through cross-correlation of several of the following signals, which may include exhaust temperature, PN, CO_2, O_2 measurements in combination with vehicle speed and acceleration. If the vehicle has a regeneration recognition feature, it shall be used to determine the occurrence of regeneration. The manufacturer may advise how to recognise whether regeneration has taken place in case such a signal is not available.

5.3.4.3. If regeneration occurred during the test, the final emission result without the application of either the K_i factor or the K_i offset shall be checked against applicable emission limits. If the final emissions are above the emission limits, then the test shall be invalid and repeated once. The completion of the regeneration and stabilisation, through approximately 1 hour of driving, shall be done prior to the start of the second test. The second test is considered valid even if regeneration occurs during it.

Even if the final emission results fall below the applicable emission limits, the occurrence of regeneration may be verified as in paragraph 5.3.4.2. If the presence of regeneration can be proved and with the agreement of the Type Approval Authority, the final results shall be calculated without the application of either the K_i factor or the Ki offset.

5.4. **PEMS operational requirements**

The trip shall be selected in such a way that the testing is uninterrupted and the data continuously recorded to reach the minimum test duration defined in paragraph 6.3.

Electrical power shall be supplied to the PEMS by an external power supply unit and not from a source that draws its energy either directly or indirectly from the engine of the test vehicle.

The installation of the PEMS equipment shall be done in a way to minimise the influence on the vehicle's emissions or performance or both to the greatest extent possible. Care should be exercised to minimise the mass of the installed equipment and potential aerodynamic modifications of the test vehicle.

During type approval, a validation test in the laboratory shall be performed before running an RDE test according to Appendix 6. For OVC-HEV the test shall be conducted in Charge Sustaining vehicle operation.

5.5. **Lubricating oil, fuel and reagent**

For the test performed during type approval, the fuel used for RDE testing shall be either the reference fuel defined in Annex B3 of the UN Regulation No 154 or within the specifications issued by the manufacturer for vehicle operation by the customer. The reagent (where applicable) and lubricant used shall be within the specifications recommended or issued by the manufacturer.

For tests performed during ISC, or Market Surveillance the fuel used for RDE testing may be any fuel legally available in the market ([5]) and within the specifications issued by the manufacturer for vehicle operation by the customer.

In the case of an RDE test with a failed result, samples of fuel, lubricant and reagent (if applicable) shall be taken and kept for at least 1 year under conditions guaranteeing the integrity of the sample. Once analysed, the samples can be discarded.

([5]) See Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (OJ L 140, 5.6.2009, p. 88).

6. TEST PROCEDURE

6.1. **Types of speed bins**

Urban speed bin is characterised by vehicle speeds lower than or equal to 60 km/h.

Rural speed bin is characterised by vehicle speeds higher than 60 km/h and lower than or equal to 90 km/h. For those vehicles that are equipped with a device permanently limiting vehicle speed to 90 km/h, rural speed bin is characterised by vehicle speed higher than 60 km/h and lower than or equal to 80 km/h.

Motorway speed bin is characterised by speeds above 90 km/h.

For those vehicles that are equipped with a device permanently limiting vehicle speed to 100 km/h, motorway speed bin is characterised by speed higher than 90 km/h.

For those vehicles that are equipped with a device permanently limiting vehicle speed to 90 km/h, motorway speed bin is characterised by speed higher than 80 km/h.

6.1.1. *Other requirements*

The average speed (including stops) of the urban speed bin shall be between 15 and 40 km/h.

The speed range of the motorway driving shall properly cover a range between 90 and at least 110 km/h. The vehicle's velocity shall be above 100 km/h for at least 5 minutes.

For those vehicles that are equipped with a device permanently limiting vehicle speed to 100 km/h, the speed range of the motorway speed bin shall properly cover a range between 90 and 100 km/h. The vehicle's velocity shall be above 90 km/h for at least 5 minutes.

For those vehicles that are equipped with a device limiting vehicle speed to 90 km/h, the speed range of the motorway speed bin of shall properly cover a range between 80 and 90 km/h. The vehicle's velocity shall be above 80 km/h for at least 5 minutes.

In the case that the local speed limits for the specific vehicle being tested prevent compliance with the requirements of this paragraph, the requirements of the following paragraph shall apply:

The speed range of the motorway driving shall properly cover a range between X – 10 and X km/h. The vehicle's velocity shall be above x – 10 km/h for at least 5 minutes. Where X = the local speed limit for the tested vehicle.

6.2. **Required distance shares of trip speed bins**

The following is the distribution of the speed bins in an RDE trip that are required for respecting the needs of evaluation: The trip shall consist of approximately 34 % per cent urban, 33 % per cent rural and 33 % per cent motorway speed bins. 'Approximately' shall mean the interval of ± 10 per cent points around the stated percentages. The urban speed bin shall however never be less than 29 % of the total trip distance.

The shares of urban, rural and motorway speed bins shall be expressed as a percentage of the total trip distance.

The minimum distance of each, urban, rural and motorway speed bins shall be 16 km.

6.3. **RDE test to be performed**

The RDE performance shall be demonstrated by testing vehicles on the road, operated over their normal driving patterns, conditions and payloads. RDE tests shall be conducted on paved roads (e.g. off-road operation is not permitted). An RDE trip shall be driven in order to prove compliance with the emission requirements.

6.3.1. The design of the trip shall be such as to comprise driving that would in principle cover all of the required shares of speed bins in paragraph 6.2 and comply with all other requirements described in paragraph 6.1.1. and 6.3, paragraph 4.5.1. of Appendix 8 and section 4. of Appendix 9.

6.3.2. The planned RDE trip shall always start with urban operation followed by rural, then motorway operation, in accordance with the required shares for speed bins in paragraph 6.2. The urban, rural and motorway operation shall be run consecutively, but may also include a trip which starts and ends at the same point. Rural operation may be interrupted by short periods of urban speed bin when driving through urban areas. Motorway operation may be interrupted by short periods of urban or rural speed bins, e.g., when passing toll stations or sections of road work.

6.3.3. The vehicle speed shall normally not exceed 145 km/h. This maximum speed may be exceeded by a tolerance of 15 km/h for not more than 3 per cent of the time duration of the motorway operation. Local speed limits remain in force during a PEMS test, notwithstanding other legal consequences. Violations of local speed limits per se do not invalidate the results of a PEMS test.

Stop periods, defined by vehicle speed of less than 1 km/h, shall account for 6-30 per cent of the time duration of urban operation. Urban operation may contain several stop periods of 10 s or longer. If stop periods in urban driving part are over 30 per cent or there are individual stop periods exceeding 300 consecutive seconds, the test shall be invalid only if the emission limits are not met.

The trip duration shall be between 90 and 120 minutes.

The start and the end points of a trip shall not differ in their elevation above sea level by more than 100 m. In addition, the proportional cumulative positive altitude gain over the entire trip and over the urban operation shall be less than 1,200 m/100 km and be determined in accordance with Appendix 10.

6.3.4. The average speed (including stops) during cold start period shall be between 15 and 40 km/h. The maximum speed during the cold start period shall not exceed 60 km/h.

At the test start, the vehicle shall move within 15 seconds. The vehicle stop periods during the entire cold start period, as defined in paragraph 2.5.1., shall be kept to the minimum possible and it shall not exceed 90 s in total.

6.4. **Other trip requirements**

If the engine stalls during the test, it may be restarted, but the sampling and data recording shall not be interrupted. If the engine stops during the test, the sampling and data recording shall not be interrupted.

In general, the exhaust mass flow shall be determined by measurement equipment functioning independently from the vehicle. With agreement of the authority vehicle ECU data may be used in this respect during initial type approval.

If the approval authority is not satisfied with the data quality check and validation results of a PEMS test conducted in accordance with Appendix 4, the approval authority may consider the test to be invalid. In such case, the test data and the reasons for invalidating the test shall be recorded by the approval authority.

The manufacturer shall demonstrate to the approval authority that the chosen vehicle, driving patterns, conditions and payloads are representative of the PEMS test family. The ambient conditions and payload requirements, as specified in paragraph 5.1. and paragraph 5.3.1. respectively, shall be used ex-ante to determine whether the conditions are acceptable for RDE testing.

The approval authority shall propose a test trip in urban, rural and motorway operation meeting the requirements of paragraph 6.2. If applicable, for the purpose of trip design, the urban, rural and motorway parts shall be selected based on a topographic map. If for a vehicle the collection of ECU data influences the vehicle's emissions or performance, the entire PEMS test family to which the vehicle belongs shall be considered as non-compliant.

For RDE tests performed during type approval, the type approval authority may verify if the test setup and the equipment used fulfil the requirements of Appendices 4 and 5 through a direct inspection or an analysis of the supporting evidence (e.g. photographs, records).

6.5. **Compliance of software tools**

Any software tool used to verify the trip validity and calculate emissions compliance with the provisions laid down in paragraphs 5 and 6 and Appendices 7, 8, 9, 10 and 11 shall be validated by an entity defined by the Member State. Where such software tool is incorporated in the PEMS instrument, proof of the validation shall be provided along with the instrument.

7. TEST DATA ANALYSIS

7.1. **Emissions and trip evaluation**

The test shall be conducted in accordance with Appendix 4.

7.2. **The trip validity shall be assessed in a three-step procedure as follows:**

STEP A: The trip complies with the general requirements, boundary conditions, trip and operational requirements, and the specifications for lubricating oil, fuel and reagents set out in Sections 5 and 6 and Appendix 10;

STEP B: The trip complies with the requirements set out in Appendix 9.

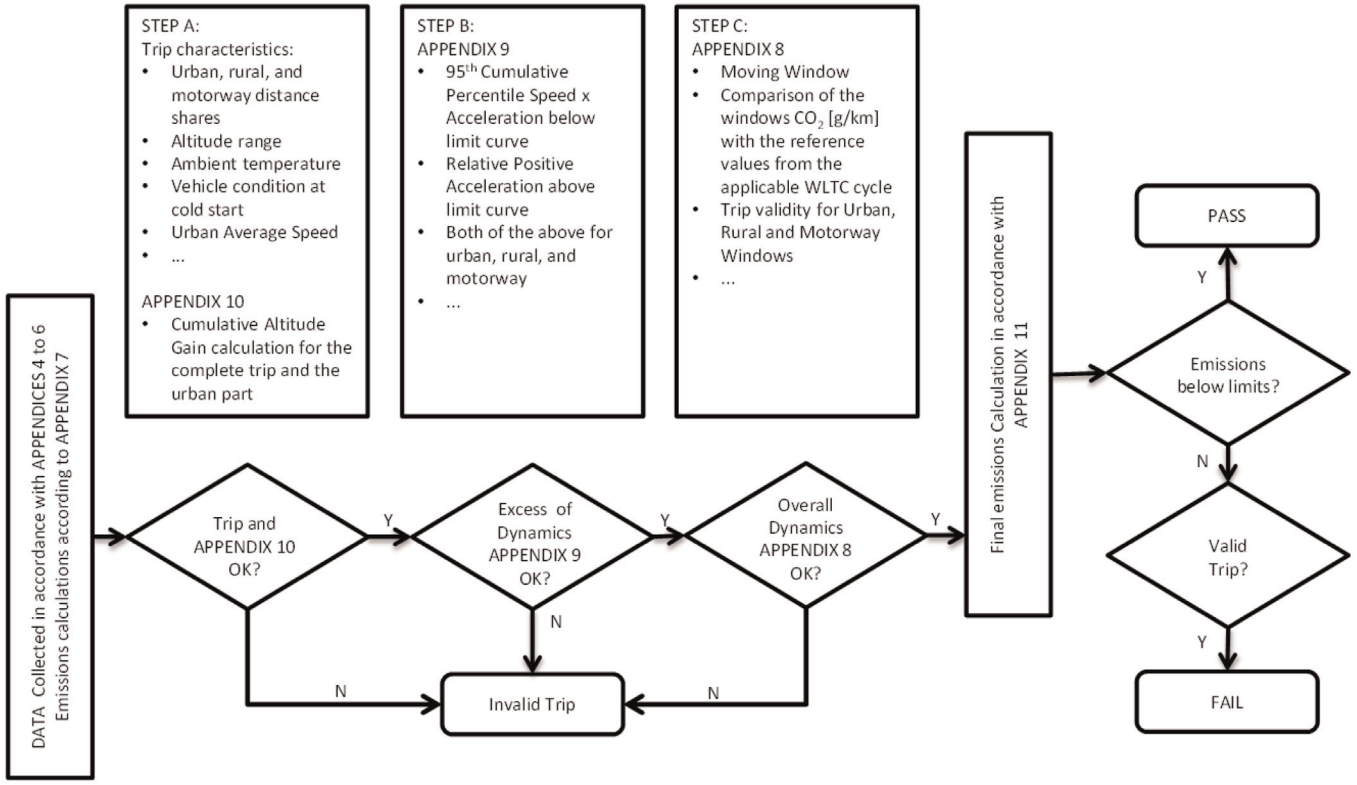
STEP C: The trip complies with the requirements set out in Appendix 8.

The steps of the procedure are detailed in Figure 6.

If at least one of the requirements is not fulfilled, the trip shall be declared invalid.

Figure 6

Assessment of trip validity – schematic (i.e. not all details are included in the steps included in the figure, see the relevant Appendices for such details)



7.3. In order to preserve data integrity, it shall not be permitted to combine data of different RDE trips in a single data set or to modify or remove data from an RDE trip, except for cases mentioned explicitly in this Annex.

7.4. Emission results shall be calculated using the methods laid down in Appendix 7 and Appendix 11. The emissions calculations shall be made between test start and test end.

7.5. The extended factor for this Annex is set at 1.6. If during a particular time interval the ambient conditions are extended, in accordance with paragraph 5.1., then the pollutant emissions calculated according to Appendix 7, during that particular time interval, shall be divided by the extended factor. This provision does not apply to carbon dioxide emissions.

7.6. Gaseous pollutant and particle number emissions during the cold start period, as defined in paragraph 2.6.1., shall be included in the normal evaluation in accordance with Appendices 7 and 11.

If the vehicle was conditioned for the last three hours prior to the test at an average temperature that falls within the extended range in accordance with paragraph 5.1., then the provisions of paragraph 7.5. apply to the data collected during the cold start period, even if the test ambient conditions are not within the extended temperature range.

7.7. **Data Reporting**

7.7.1. *General*

All data of a single RDE test shall be recorded according to the data exchange and data reporting files provided by the Commission ([6]).

7.7.2. *Reporting and dissemination of RDE type approval test information*

7.7.2.1. A technical report prepared by the manufacturer shall be made available to the approval authority. The technical report is composed of 4 items:

(i) the Data Exchange file

(ii) the Reporting file

(iii) the Vehicle and engine description as described in Appendix 4 of Annex I of Regulation 2017/1151;

(iv) visual supporting material (photographs and/or videos) of the PEMS installation in the tested vehicle of adequate quality and quantity to identify the vehicle and to assess if the installation of the PEMS main unit, the EFM, the GNSS antenna, and the weather station follow the instrument manufacturers recommendations and the general good practices of PEMS testing.

([6]) To be found in CIRCABC link: https://circabc.europa.eu/ui/group/f4243c55-615c-4b70-a4c8-1254b5eebf61/library/a0be83ba-89bd-4499-8189-2696362d2f72?p=1

7.7.2.2. The manufacturer shall ensure that the information listed in point 7.7.2.2.1. is made available on a publicly accessible website without costs and without the need for the user to reveal his identity or sign up. The manufacturer shall keep the Commission and Type Approval Authorities informed on the location of the website.

7.7.2.2.1. The website shall allow a wildcard search of the underlying database based on one or more of the following:

Make, Type, Variant, Version, Commercial name, or Type Approval Number as referred to in the certificate of conformity, pursuant to Annex IX to Directive 2007/46/EC or Annex VIII to Commission Implementing Regulation (EU) 2020/683.

The information described below shall be made available for each vehicle in a search:

— The PEMS family ID to which that vehicle belongs, in accordance with the Transparency List 2 set out in Table 1 of Appendix 5 to Annex II;

— The Declared Maximum RDE Values as reported in point 48.2 of the Certificate of Conformity, as described in Annex VIII to Commission Implementing Regulation (EU) 2020/683.

7.7.2.3. Upon request, without costs and within 10 days, the manufacturer shall make available the technical report referred to in point 7.7.2.1 to any third party and the Commission. The manufacturer shall also make available the technical report referred to in point 7.7.2.1 upon request and with a reasonable and proportionate fee to others, which does not discourage an inquirer with a justified interest from requesting the respective information or exceed the internal costs of the manufacturer for making the requested information available.

Upon request, the type approval authority shall make available the information listed under points 7.7.2.1 and 7.7.2.2 without costs and within 10 days of receiving the request to any third party or the Commission. The type approval authority shall also make available to others upon request the information listed under points 7.7.2.1 and 7.7.2.2 with a reasonable and proportionate fee, which does not discourage an inquirer with a justified interest from requesting the respective information or exceed the internal costs of the authority for making the requested information available.

Appendix 1

Reserved

Appendix 2

Reserved

Appendix 3

Reserved

Appendix 4

Test procedure for vehicle emissions testing with a portable emissions measurement system (PEMS)

Test procedure for vehicle emissions testing with a portable emissions measurement system (PEMS)

1. INTRODUCTION

This appendix describes the test procedure to determine pollutant emissions from passenger and light commercial vehicles using a Portable Emissions Measurement System.

2. SYMBOLS, PARAMETERS AND UNITS

p_e	—	evacuated pressure [kPa]
q_{vs}	—	volume flow rate of the system [l/min]
$ppmC_1$	—	parts per million carbon equivalent
V_s	—	system volume [l]

3. GENERAL REQUIREMENTS

3.1. **PEMS**

The test shall be carried out with a PEMS, composed of components specified in paragraphs 3.1.1. to 3.1.5. If applicable, a connection with the vehicle ECU may be established to determine relevant engine and vehicle parameters as specified in paragraph 3.2.

3.1.1. Analysers to determine the concentration of pollutants in the exhaust gas.

3.1.2. One or multiple instruments or sensors to measure or determine the exhaust mass flow.

3.1.3. A GNSS receiver to determine the position, altitude and, speed of the vehicle.

3.1.4. If applicable, sensors and other appliances being not part of the vehicle, e.g. to measure ambient temperature, relative humidity and air pressure.

3.1.5. An energy source independent of the vehicle to power the PEMS.

3.2. **Test parameters**

Test parameters, as specified in Table A4/1, shall be measured at a constant frequency of 1.0 Hz or higher and recorded and reported in accordance with the requirements of paragraph 10. of Appendix 7 at a sampling frequency of 1.0 Hz. If ECU parameters are obtained, these may be obtained at a substantially higher frequency but the recording rate shall be 1.0 Hz. The PEMS analysers, flow-measuring instruments and sensors shall comply with the requirements laid down in Appendices 5 and 6.

Table A4/1

Test parameters

Parameter	Recommended unit	Source ([7])
THC concentration ([8]), ([9]) (if applicable)	ppm C_1	Analyser
CH_4 concentration ([7]), ([8]), ([9]) (if applicable)	ppm C_1	Analyser
NMHC concentration ([7]), ([8]), ([9]) (if applicable)	ppm C_1	Analyser ([10])

([7]) Multiple parameter sources may be used.
([8]) To be measured on a wet basis or to be corrected as described in paragraph 5.1. of Appendix 7.
([9]) Parameter only mandatory if measurement required for compliance with the limits.
([10]) May be calculated from THC and CH_4 concentrations according to paragraph 6.2. to Appendix 7.

Parameter	Recommended unit	Source ([7])
CO concentration ([7]), ([8]), ([9])	ppm	Analyser
CO_2 concentration ([8])	ppm	Analyser
NO_X concentration ([8]), ([9])	ppm	Analyser ([11])
PN concentration ([9])	#/m^3	Analyser
Exhaust mass flow rate	kg/s	EFM, any methods described in paragraph 7. of Appendix 5.
Ambient humidity	%	Sensor
Ambient temperature	K	Sensor
Ambient pressure	kPa	Sensor
Vehicle speed	km/h	Sensor, GNSS, or ECU ([12])
Vehicle latitude	Degree	GNSS
Vehicle longitude	Degree	GNSS
Vehicle altitude ([13]), ([14])	m	GNSS or Sensor
Exhaust gas temperature ([13])	K	Sensor
Engine coolant temperature ([13])	K	Sensor or ECU
Engine speed ([13])	RPM	Sensor or ECU
Engine torque ([13])	Nm	Sensor or ECU
Torque at driven axle ([13]) (if applicable)	Nm	Rim torque meter
Pedal position ([13])	%	Sensor or ECU
Engine fuel flow ([15]) (if applicable)	g/s	Sensor or ECU
Engine intake air flow ([15]) (if applicable)	g/s	Sensor or ECU
Fault status ([13])	—	ECU
Intake air flow temperature	K	Sensor or ECU
Regeneration status ([13]) (if applicable)	—	ECU
Engine oil temperature ([13])	K	Sensor or ECU
Actual gear ([13])	#	ECU
Desired gear (e.g. gear shift indicator) ([13])	#	ECU
Other vehicle data ([13])	unspecified	ECU

3.4. **Installation of PEMS**

3.4.1. *General*

The installation of the PEMS shall follow the instructions of the PEMS manufacturer and the local health and safety regulations. When the PEMS is installed inside the vehicle, the vehicle should be equipped with gas monitors or warning systems for hazardous gases (e.g. CO). The PEMS should be installed as to minimise electromagnetic interferences during the test as well as exposure to shocks, vibration, dust and variability in temperature. The installation and operation of the PEMS shall be such that it avoids leakage and minimise heat

([11]) May be calculated from measured NO and NO_2 concentrations.
([12]) Method to be chosen according to paragraph 4.7. of this Appendix.
([13]) To be determined only if necessary to verify the vehicle status and operating conditions.
([14]) The preferable source is the ambient pressure sensor.
([15]) To be determined only if indirect methods are used to calculate exhaust mass flow rate as described in paragraphs 7.2. and 7.4. of Appendix 7.

loss. The installation and operation of PEMS shall not change the nature of the exhaust gas nor unduly increase the length of the tailpipe. To avoid the generation of particles, connectors shall be thermally stable at the exhaust gas temperatures expected during the test. It is recommended to avoid the use elastomer connectors to connect the vehicle exhaust outlet and the connecting tube. Elastomer connectors, if used, shall have no contact with the exhaust gas to avoid artefacts. If the test performed with the use of elastomer connectors fails, the test shall be repeated without the use of elastomer connectors.

3.4.2. *Permissible backpressure*

The installation and operation of the PEMS sampling probes shall not unduly increase the pressure at the exhaust outlet in a way that may influence the representativeness of the measurements. It is thus recommended that only one sampling probe is installed in the same plane. If technically feasible, any extension to facilitate the sampling or connection with the exhaust mass flow meter shall have an equivalent, or larger, cross sectional area than the exhaust pipe.

3.4.3. *Exhaust mass flow meter*

Whenever used, the exhaust mass flow meter shall be attached to the vehicle's tailpipe(s) in accordance with the recommendations of the EFM manufacturer. The measurement range of the EFM shall match the range of the exhaust mass flow rate expected during the test. It is recommended to select the EFM so that the maximum expected flow rate during the test reaches at least 75 per cent of the EFM full range but does not exceed the EFM full range. The installation of the EFM and any exhaust pipe adaptors or junctions shall not adversely affect the operation of the engine or exhaust after-treatment system. A minimum of four pipe diameters or 150 mm of straight tubing, whichever is larger, shall be placed at either side of the flow-sensing element. When testing a multi-cylinder engine with a branched exhaust manifold, it is recommended to position the exhaust mass flow meter downstream of where the manifolds combine and to increase the cross section of the piping such as to have an equivalent, or larger, cross sectional area from which to sample. If this is not feasible, exhaust flow measurements with several exhaust mass flow meters may be used. The wide variety of exhaust pipe configurations, dimensions and exhaust mass flow rates may require compromises, guided by good engineering judgement, when selecting and installing the EFM(s). It is permissible to install an EFM with a diameter smaller than that of the exhaust outlet or the total cross-sectional area of multiple outlets, providing it improves measurement accuracy and does not adversely affect the operation or the exhaust after-treatment as specified in paragraph 3.4.2. It is recommended to document the EFM set-up using photographs.

3.4.4. *Global Positioning System (GNSS)*

The GNSS antenna shall be mounted as near as possible to the highest location on the vehicle, so as to ensure good reception of the satellite signal. The mounted GNSS antenna shall interfere as little as possible with the vehicle operation.

3.4.5. *Connection with the Engine Control Unit (ECU)*

If desired, relevant vehicle and engine parameters listed in Table A4/1 can be recorded by using a data logger connected with the ECU or the vehicle network through national or international standards, such as ISO 15031-5 or SAE J1979, OBD-II, EOBD or WWH-OBD. If applicable, manufacturers shall disclose labels to allow the identification of required parameters.

3.4.6. *Sensors and auxiliary devices*

Vehicle speed sensors, temperature sensors, coolant thermocouples or any other measurement device not part of the vehicle shall be installed to measure the parameter under consideration in a representative, reliable and accurate manner without unduly interfering with the vehicle operation and the functioning of other analysers, flow-measuring instruments, sensors and signals. Sensors and auxiliary equipment shall be powered independently of the vehicle. It is permitted to power any safety-related illumination of fixtures and installations of PEMS components outside of the vehicle's cabin by the vehicle's battery.

3.5. **Emissions sampling**

Emissions sampling shall be representative and conducted at locations of well-mixed exhaust, where the influence of ambient air downstream of the sampling point is minimal. If applicable, emissions shall be sampled downstream of the exhaust mass flow meter, respecting a distance of at least 150 mm to the flow sensing element. The sampling probes shall be fitted at least 200 mm or three times the inner diameter of the exhaust pipe, whichever is larger, upstream of the point at which the exhaust gas exits the PEMS sampling installation into the environment.

If the PEMS feeds part of the sample back to the exhaust flow, this shall occur downstream of the sampling probe in a manner that does not affect the nature of the exhaust gas at the sampling point(s). If the length of the sampling line is changed, the system transport times shall be verified and, if necessary, corrected. If the vehicle is equipped with more than one tailpipe then all functioning tailpipes shall be connected before sampling and measuring exhaust flow.

If the engine is equipped with an exhaust after-treatment system, the exhaust sample shall be taken downstream of the exhaust after-treatment system. When testing a vehicle with a branched exhaust manifold, the inlet of the sampling probe shall be located sufficiently far downstream so as to ensure that the sample is representative of the average pollutant emissions of all cylinders. In multi-cylinder engines, having distinct groups of manifolds, such as in a 'V' engine configuration, the sampling probe shall be positioned downstream of where the manifolds combine. If this is technically not feasible, multi-point sampling at locations of well-mixed exhaust may be used. In this case, the number and location of sampling probes shall match as far as possible those of the exhaust mass flow meters. In case of unequal exhaust flows, proportional sampling or sampling with multiple analysers shall be considered.

If particles are measured, they shall be sampled from the centre of the exhaust stream. If several probes are used for emissions sampling, the particle sampling probe should be placed upstream of the other sampling probes. The particle sampling probe should not interfere with the sampling of gaseous pollutants. The type and specifications of the probe and its mounting shall be documented in detail (e.g. L type or 45° cut, internal diameter, with or without hat, etc).

If hydrocarbons are measured, the sampling line shall be heated to 463 ± 10 K (190 ± 10 °C). For the measurement of other gaseous components, with or without cooler, the sampling line shall be kept at a minimum of 333 K (60 °C) to avoid condensation and to ensure appropriate penetration efficiencies of the various gases. For low pressure sampling systems, the temperature can be lowered correspondingly to the pressure decrease provided that the sampling system ensures a penetration efficiency of 95 per cent for all regulated gaseous pollutants. If particles are sampled and not diluted at the tailpipe, the sampling line from the raw exhaust sample point to the point of dilution or particle detector shall be heated to a minimum of 373 K (100 °C). The residence time of the sample in the particle sampling line shall be less than 3 s until reaching first dilution or the particle detector.

All parts of the sampling system from the tailpipe up to the particle detector, which are in contact with raw or diluted exhaust gas, shall be designed to minimize deposition of particles. All parts shall be made from antistatic material to prevent electrostatic effects.

4. PRE-TEST PROCEDURES

4.1. **PEMS leak check**

After the installation of the PEMS is completed, a leak check shall be performed at least once for each PEMS-vehicle installation as prescribed by the PEMS manufacturer or as follows. The probe shall be disconnected from the exhaust system and the end plugged. The analyser pump shall be switched on. After an initial stabilization period, all flow meters shall read approximately zero in the absence of a leak. If this is not the case the sampling lines shall be checked and the fault shall be corrected.

The leakage rate on the vacuum side shall not exceed 0.5 per cent of the in-use flow rate for the portion of the system being checked. The analyser flows and bypass flows may be used to estimate the in-use flow rate.

Alternatively, the system may be evacuated to a pressure of at least 20 kPa vacuum (80 kPa absolute). After an initial stabilization period the pressure increase Δp (kPa/min) in the system shall not exceed:

$$\Delta p = \frac{p_e}{V_s} \times q_{vs} \times 0{,}005$$

where:

p_e is the evacuated pressure [Pa],

V_s is the system volume [l],

q_{vs} is the volume flow rate of the system [l/min].

Alternatively, a concentration step change at the beginning of the sampling line shall be introduced by switching from zero to span gas while maintaining the same pressure conditions as under normal system operation. If for a correctly calibrated analyser after an adequate period of time the reading is ≤ 99 per cent compared to the introduced concentration, the leakage problem shall be corrected.

4.2. **Starting and stabilizing the PEMS**

The PEMS shall be switched on, warmed up and stabilized in accordance with the specifications of the PEMS manufacturer until key functional parameters (e.g., pressures, temperatures and flows) have reached their operating set points before test start. To ensure correct functioning, the PEMS may be kept switched on or can be warmed up and stabilized during vehicle conditioning. The system shall be free of errors and critical warnings.

4.3. **Preparing the sampling system**

The sampling system, consisting of the sampling probe and sampling lines shall be prepared for testing by following the instruction of the PEMS manufacturer. It shall be ensured that the sampling system is clean and free of moisture condensation.

4.4. **Preparing the Exhaust mass Flow Meter (EFM)**

If used for measuring the exhaust mass flow, the EFM shall be purged and prepared for operation in accordance with the specifications of the EFM manufacturer. This procedure shall, if applicable, remove condensation and deposits from the lines and the associated measurement ports.

4.5. **Checking and calibrating the analysers for measuring gaseous emissions**

Zero and span calibration adjustments of the analysers shall be performed using calibration gases that meet the requirements of paragraph 5. of Appendix 5. The calibration gases shall be chosen to match the range of pollutant concentrations expected during the RDE test. To minimise analyser drift, it is recommended to conduct the zero and span calibration of analysers at an ambient temperature that resembles, as closely as possible, the temperature experienced by the test equipment during the trip.

4.6. **Checking the analyser for measuring particle emissions**

The zero level of the analyser shall be recorded by sampling HEPA filtered ambient air at an appropriate sampling point, ideally at the inlet of the sampling line. The signal shall be recorded at a constant frequency which is a multiple of 1.0 Hz averaged over a period of 2 minutes. The final concentration shall be within the manufacturer's specifications, but shall not exceed 5,000 particles per cubic-centimetre.

4.7. **Determining vehicle speed**

Vehicle speed shall be determined by at least one of the following methods:

(a) a sensor (e.g., optical or micro-wave sensor); if vehicle speed is determined by a sensor, the speed measurements shall comply with the requirements of paragraph 8. of Appendix 5, or alternatively, the total trip distance determined by the sensor shall be compared with a reference distance obtained from a digital road network or topographic map. The total trip distance determined by the sensor shall deviate by no more than 4 per cent from the reference distance.

(b) the ECU; if vehicle speed is determined by the ECU, the total trip distance shall be validated according to paragraph 3. of Appendix 6 and the ECU speed signal adjusted, if necessary, to fulfil the requirements of paragraph 3. of Appendix 6. Alternatively, the total trip distance as determined by the ECU can be compared with a reference distance obtained from a digital road network or topographic map. The total trip distance determined by the ECU shall deviate by no more than 4 per cent from the reference distance.

(c) a GNSS; if vehicle speed is determined by a GNSS, the total trip distance shall be checked against the measurements of another method according to paragraph 6.5. of Appendix 4.

4.8. **Check of PEMS set up**

The correctness of connections with all sensors and, if applicable, the ECU shall be verified. If engine parameters are retrieved, it shall be ensured that the ECU reports values correctly (e.g., zero engine speed [rpm] while the combustion engine is in key-on-engine-off status). The PEMS shall function free of errors and critical warnings.

5. EMISSIONS TEST

5.1. **Test start**

Sampling, measurement and recording of parameters shall begin prior to the test start (as defined in point 2.6.5. of this Annex). Before the test start it shall be confirmed that all necessary parameters are recorded by the data logger.

To facilitate time alignment, it is recommended to record the parameters that are subject to time alignment either by a single data recording device or with a synchronised time stamp.

5.2. **Test**

Sampling, measurement and recording of parameters shall continue throughout the on-road test of the vehicle. The engine may be stopped and started, but emissions sampling and parameter recording shall continue. Repeated stalling of the engine (i.e. unintentional stopping of the engine) should be avoided during an RDE trip. Any warning signals, suggesting malfunctioning of the PEMS, shall be documented and verified. If any error signal(s) appear during the test, the test shall be invalid. Parameter recording shall reach a data completeness of higher than 99 per cent. Measurement and data recording may be interrupted for less than 1 per cent of the total trip duration but for no more than a consecutive period of 30 s solely in the case of unintended signal loss or for the purpose of PEMS system maintenance. Interruptions may be recorded directly by the PEMS but it is not permissible to introduce interruptions in the recorded parameter via the pre-processing, exchange or post-processing of data. If conducted, auto zeroing shall be performed against a traceable zero standard similar to the one used to zero the analyser. It is strongly recommended to initiate PEMS system maintenance during periods of zero vehicle speed.

5.3. **Test end**

Excessive idling of the engine after the completion of the trip shall be avoided. The data recording shall continue after the test end (as defined in paragraph 2.6.6. of this Annex) and until the response time of the sampling systems has elapsed. For vehicles with a signal detecting regeneration, the OBD-check shall be performed and documented directly after data recording and before any further driven distance is driven.

6. POST-TEST PROCEDURE

6.1. **Checking the analysers for measuring gaseous emissions**

The zero and span of the analysers of gaseous components shall be checked by using calibration gases identical to the ones applied under paragraph 4.5. to evaluate the analyser's zero and response drift compared to the pre-test calibration. It is permissible to zero the analyser prior to verifying the span drift, if the zero drift was determined to be within the permissible range. The post-test drift check shall be completed as soon as possible after the test and before the PEMS, or individual analysers or sensors, are turned off or have switched into a non-operating mode. The difference between the pre-test and post-test results shall comply with the requirements specified in Table A4/2.

Table A4/2

Permissible analyser drift over a PEMS test

Pollutant	Absolute Zero response drift	Absolute Span response drift ([16])
CO_2	≤ 2 000 ppm, per test	≤ 2 % of reading or ≤ 2 000 ppm per test, whichever is larger
CO	≤ 75 ppm per test	≤ 2 % of reading or ≤ 75 ppm per test, whichever is larger
NO_X	≤ 3 ppm per test	≤ 2 % of reading or ≤ 3 ppm per test, whichever is larger
CH_4	≤ 10 ppm C_1 per test	≤ 2 % of reading or ≤ 10 ppm C_1 per test, whichever is larger
THC	≤ 10 ppm C_1 per test	≤ 2 % of reading or ≤ 10 ppm C_1 per test, whichever is larger

If the difference between the pre-test and post-test results for the zero and span drift is higher than permitted, all test results shall be invalid and the test repeated.

6.2. **Checking the analyser for measuring particle emissions**

The zero level of the analyser shall be recorded in accordance with paragraph 4.6.

6.3. **Checking the on-road emission measurements**

The span gas concentration that was used for the calibration of the analysers in accordance with paragraph 4.5. at the test start shall cover at least 90 per cent of the concentration values obtained from 99 per cent of the measurements of the valid parts of the emissions test. It is permissible that 1 per cent of the total number of measurements used for evaluation exceeds the concentration of the span gas used by up to a factor of two. If these requirements are not met, the test shall be invalid.

6.4. **Consistency check of vehicle altitude**

In case altitude has only been measured with a GNSS, the GNSS altitude data shall be checked for consistency and, if necessary, corrected. The consistency of data shall be checked by comparing the latitude, longitude and altitude data obtained from the GNSS with the altitude indicated by a digital terrain model or a topographic map of suitable scale. Measurements that deviate by more than 40 m from the altitude depicted in the topographic map shall be manually corrected. The original and uncorrected data shall be retained and any corrected data shall be marked.

The instantaneous altitude data shall be checked for completeness. Data gaps shall be completed by data interpolation. The correctness of interpolated data shall be verified by a topographic map. It is recommended to correct interpolated data if the following condition applies:

$$|h_{GNSS}(t) - h_{map}(t)| > 40\ m$$

The altitude correction shall be applied so that:

$$|h(t) - h_{map}(t)| < 40\ m$$

([16]) If the zero drift is within the permissible range, it is permissible to zero the analyser prior to verifying the span drift.

where:

$h(t)$	—	vehicle altitude after the screening and principle check of data quality at data point t [m above sea level]
$h_{GNSS}(t)$	—	vehicle altitude measured with GNSS at data point t [m above sea level]
$h_{map}(t)$	—	vehicle altitude based on topographic map at data point t [m above sea level]

6.5. **Consistency check of GNSS vehicle speed**

The vehicle speed as determined by the GNSS shall be checked for consistency by calculating and comparing the total trip distance with reference measurements obtained from either a sensor, the validated ECU or, alternatively, from a digital road network or topographic map. It is mandatory to correct GNSS data for obvious errors, e.g., by applying a dead reckoning sensor, prior to the consistency check. The original and uncorrected data shall be retained and any corrected data shall be marked. The corrected data shall not exceed an uninterrupted time period of 120 s or a total of 300 s. The total trip distance as calculated from the corrected GNSS data shall deviate by no more than 4 per cent from the reference. If the GNSS data do not meet these requirements and no other reliable speed source is available, the test shall be invalid.

6.6. **Consistency check of the ambient temperature**

The ambient temperature data shall be checked for consistency and inconsistent values corrected by substituting outliers with the average of the neighbouring values. The original and uncorrected data shall be retained and any corrected data shall be marked.

Appendix 5

Specifications and calibration of PEMS components and signals

1. INTRODUCTION

This appendix sets out the specifications and calibration of PEMS components and signals

2. SYMBOLS, PARAMETERS AND UNITS

A	—	undiluted CO_2 concentration [%]
a_0	—	y-axis intercept of the linear regression line
a_1	—	slope of the linear regression line
B	—	diluted CO_2 concentration [%]
C	—	diluted NO concentration [ppm]
c	—	analyser response in the oxygen interference test
C_b		Measured diluted NO concentration through bubbler
$c_{FS,b}$	—	full scale HC concentration in step (b) [ppmC_1]
$c_{FS,d}$	—	full scale HC concentration in step (d) [ppmC_1]
$c_{HC(w/NMC)}$	—	HC concentration with CH_4 or C_2H_6 flowing through the NMC [ppmC_1]
$c_{HC(w/o\ NMC)}$	—	HC concentration with CH_4 or C_2H_6 bypassing the NMC [ppmC_1]
$c_{m,b}$	—	measured HC concentration in step (b) [ppmC_1]
$c_{m,d}$	—	measured HC concentration in step (d) [ppmC_1]
$c_{ref,b}$	—	reference HC concentration in step (b) [ppmC_1]
$c_{ref,d}$	—	reference HC concentration in step (d) [ppmC_1]
D	—	undiluted NO concentration [ppm]
D_e	—	expected diluted NO concentration [ppm]
E	—	absolute operating pressure [kPa]
E_{CO_2}	—	per cent CO_2 quench
$E(d_p)$	—	PEMS-PN analyser efficiency
E_E	—	ethane efficiency
E_{H2O}	—	per cent water quench
E_M	—	methane efficiency
E_{O2}	—	oxygen interference
F	—	water temperature [K]
G	—	saturation vapour pressure [kPa]
H	—	water vapour concentration [%]

H_m	—	maximum water vapour concentration [%]
$NO_{X,dry}$	—	moisture-corrected mean concentration of the stabilized NO_X recordings
$NO_{X,m}$	—	mean concentration of the stabilized NO_X recordings
$NO_{X,ref}$	—	reference mean concentration of the stabilized NO_X recordings
r^2	—	coefficient of determination
t_0	—	time point of gas flow switching [s]
t_{10}	—	time point of 10 % response of the final reading
t_{50}	—	time point of 50 % response of the final reading
t_{90}	—	time point of 90 % response of the final reading
Tbd	—	to be determined
X	—	independent variable or reference value
x_{min}	—	minimum value
Y	—	dependent variable or measured value

3. LINEARITY VERIFICATION

3.1. **General**

The accuracy and linearity of analysers, flow-measuring instruments, sensors and signals shall be traceable to international or national standards. Any sensors or signals that are not directly traceable (e.g., simplified flow-measuring instruments) shall be calibrated alternatively against chassis dynamometer laboratory equipment that has been calibrated against international or national standards.

3.2. **Linearity requirements**

All analysers, flow-measuring instruments, sensors and signals shall comply with the linearity requirements given in Table A5/1. If air flow, fuel flow, the air-to-fuel ratio or the exhaust mass flow rate is obtained from the ECU, the calculated exhaust mass flow rate shall meet the linearity requirements specified in Table A5/1.

Table A5/1

Linearity requirements of measurement parameters and systems

Measurement parameter/instrument	$\lvert x_{min} \times (a_1 - 1) + a_0 \rvert$	Slope a_1	Standard error of the estimate SEE	Coefficient of determination r^2
Fuel flow rate ([17])	≤ 1 % x_{max}	0,98 – 1,02	≤ 2 % of x_{max}	≥ 0,990
Air flow rate ([15])	≤ 1 % x_{max}	0,98 – 1,02	≤ 2 % of x_{max}	≥ 0,990
Exhaust mass flow rate	≤ 2 % x_{max}	0,97 – 1,03	≤ 3 % of x_{max}	≥ 0,990
Gas analysers	≤ 0,5 % max	0,99 – 1,01	≤ 1 % of x_{max}	≥ 0,998
Torque ([18])	≤ 1 % x_{max}	0,98 – 1,02	≤ 2 % of x_{max}	≥ 0,990
PN analysers ([19])	≤ 5 % x_{max}	0,85 – 1,15 ([20])	≤ 10 % of x_{max}	≥ 0,950

([17]) Optional to determine exhaust mass flow.
([18]) Optional parameter.
([19]) The linearity check shall be verified with soot-like particles, as these are defined in paragraph 6.2. of this appendix.
([20]) To be updated based on error propagation and traceability charts.

3.3. **Frequency of linearity verification**

The linearity requirements pursuant to paragraph 3.2. shall be verified:

(a) for each gas analyser at least every 12 months or whenever a system repair or component change or modification is made that could influence the calibration;

(b) for other relevant instruments, such as PN analysers, exhaust mass flow meters and traceably calibrated sensors, whenever damage is observed, as required by internal audit procedures or by the instrument manufacturer but no longer than one year before the actual test.

The linearity requirements pursuant to paragraph 3.2. for sensors or ECU signals that are not directly traceable shall be performed using a measurement device with a traceable calibration on the chassis dynamometer, once for each PEMS-vehicle setup.

3.4. **Procedure of linearity verification**

3.4.1. *General requirements*

The relevant analysers, instruments and sensors shall be brought to their normal operating condition according to the recommendations of their manufacturer. The analysers, instruments and sensors shall be operated at their specified temperatures, pressures and flows.

3.4.2. *General procedure*

The linearity shall be verified for each normal operating range by executing the following steps:

(a) The analyser, flow-measuring instrument or sensor shall be set to zero by introducing a zero signal. For gas analysers, purified synthetic air or nitrogen shall be introduced to the analyser port via a gas path that is as direct and short as possible.

(b) The analyser, flow-measuring instrument or sensor shall be spanned by introducing a span signal. For gas analysers, an appropriate span gas shall be introduced to the analyser port via a gas path that is as direct and short as possible.

(c) The zero procedure of (a) shall be repeated.

(d) The linearity shall be verified by introducing at least 10, approximately equally spaced and valid, reference values (including zero). The reference values with respect to the concentration of components, the exhaust mass flow rate or any other relevant parameter shall be chosen to match the range of values expected during the emissions test. For measurements of exhaust mass flow, reference points below 5 per cent of the maximum calibration value can be excluded from the linearity verification.

(e) For gas analysers, known gas concentrations in accordance with paragraph 5. shall be introduced to the analyser port. Sufficient time for signal stabilisation shall be given. For particle number analysers, the particle number concentrations shall be at least two times the limit of detection (defined in point 6.2).

(f) The values under evaluation and, if needed, the reference values shall be recorded at a constant frequency which is a multiple of 1.0 Hz over a period of 30 seconds (60 s for particle number analysers).

(g) The arithmetic mean values over the 30 (or 60 s) seconds period shall be used to calculate the least squares linear regression parameters, with the best-fit equation having the form:

$$y = a_1 x + a_0$$

where:

y is the actual value of the measurement system

a_1 is the slope of the regression line

x is the reference value

a_0 is the y intercept of the regression line

The standard error of estimate (*SEE*) of y on x and the coefficient of determination (r^2) shall be calculated for each measurement parameter and system.

(h) The linear regression parameters shall meet the requirements specified in Table A5/1.

3.4.3. *Requirements for linearity verification on a chassis dynamometer*

Non-traceable flow-measuring instruments, sensors or ECU signals, that cannot directly be calibrated according to traceable standards, shall be calibrated on a chassis dynamometer. The procedure shall follow, as far as applicable, the requirements of UN Regulation No 154. If necessary, the instrument or sensor to be calibrated shall be installed on the test vehicle and operated according to the requirements of Appendix 4. The calibration procedure shall follow whenever possible the requirements of paragraph 3.4.2. At least 10 appropriate reference values shall be selected as to ensure that at least 90 per cent of the maximum value expected to occur during the RDE test is covered.

If a non-traceable flow-measuring instrument, sensor or ECU signal for determining exhaust flow is to be calibrated, a reference exhaust mass flow meter with traceable calibration or the CVS shall be attached to the vehicle's tailpipe. It shall be ensured that the vehicle exhaust is accurately measured by the exhaust mass flow meter according to paragraph 3.4.3. of Appendix 4. The vehicle shall be operated by applying constant throttle at a constant gear selection and chassis dynamometer load.

4. ANALYSERS FOR MEASURING GASEOUS COMPONENTS

4.1. **Permissible types of analysers**

4.1.1. *Standard analysers*

The gaseous components shall be measured with analysers specified in paragraph 4.1.4., Annex B5 to UN Regulation No 154. If an NDUV analyser measures both NO and NO_2, a NO_2/NO converter is not required.

4.1.2. *Alternative analysers*

Any analyser not meeting the design specifications of paragraph 4.1.1. is permissible provided that it fulfils the requirements of paragraph 4.2. The manufacturer shall ensure that the alternative analyser achieves an equivalent or higher measurement performance compared to a standard analyser over the range of pollutant concentrations and co-existing gases that can be expected from vehicles operated with permissible fuels under moderate and extended conditions of valid RDE testing as specified in paragraphs 5., 6. and 7. of this Appendix. Upon request, the manufacturer of the analyser shall submit in writing supplemental information, demonstrating that the measurement performance of the alternative analyser is consistently and reliably in line with the measurement performance of standard analysers. Supplemental information shall contain:

(a) a description of the theoretical basis and the technical components of the alternative analyser;

(b) a demonstration of equivalency with the respective standard analyser specified in paragraph 4.1.1. over the expected range of pollutant concentrations and ambient conditions of the type-approval test defined in UN Regulation No 154 as well as a validation test as described in paragraph 3. of Appendix 6 for a vehicle equipped with a spark-ignition and compression-ignition engine; the manufacturer of the analyser shall demonstrate the significance of equivalency within the permissible tolerances given in paragraph 3.3. of Appendix 6.

(c) a demonstration of equivalency with the respective standard analyser specified in paragraph 4.1.1. with respect to the influence of atmospheric pressure on the measurement performance of the analyser; the demonstration test shall determine the response to span gas having a concentration within the analyser range to check the influence of atmospheric pressure under moderate and extended altitude conditions defined in paragraph 5.2. Such a test can be performed in an altitude environmental test chamber.

(d) a demonstration of equivalency with the respective standard analyser specified in paragraph 4.1.1. over at least three on-road tests that fulfil the requirements of this Appendix.

(e) a demonstration that the influence of vibrations, accelerations and ambient temperature on the analyser reading does not exceed the noise requirements for analysers set out in paragraph 4.2.4.

Approval authorities may request additional information to substantiate equivalency or refuse approval if measurements demonstrate that an alternative analyser is not equivalent to a standard analyser.

4.2. **Analyser specifications**

4.2.1. *General*

In addition to the linearity requirements defined for each analyser in paragraph 3., the compliance of analyser types with the specifications laid down in paragraphs 4.2.2. to 4.2.8. shall be demonstrated by the analyser manufacturer. Analysers shall have a measuring range and response time appropriate to measure with adequate accuracy the concentrations of the exhaust gas components at the applicable emissions standard under transient and steady state conditions. The sensitivity of the analysers to shocks, vibration, aging, variability in temperature and air pressure as well as electromagnetic interferences and other impacts related to vehicle and analyser operation shall be limited as far as possible.

4.2.2. *Accuracy*

The accuracy, defined as the deviation of the analyser reading from the reference value, shall not exceed 2 per cent of reading or 0.3 per cent of full scale, whichever is larger.

4.2.3. *Precision*

The precision, defined as 2.5 times the standard deviation of 10 repetitive responses to a given calibration or span gas, shall be no greater than 1 per cent of the full scale concentration for a measurement range equal or above 155 ppm (or $ppmC_1$) and 2 per cent of the full scale concentration for a measurement range of below 155 ppm (or $ppmC_1$).

4.2.4. *Noise*

The noise shall not exceed 2 per cent of full scale. Each of the 10 measurement periods shall be interspersed with an interval of 30 seconds in which the analyser is exposed to an appropriate span gas. Before each sampling period and before each span period, sufficient time shall be given to purge the analyser and the sampling lines.

4.2.5. *Zero response drift*

The drift of the zero response, defined as the mean response to a zero gas during a time interval of at least 30 seconds, shall comply with the specifications given in Table A5/2.

4.2.6. *Span response drift*

The drift of the span response, defined as the mean response to a span gas during a time interval of at least 30 seconds, shall comply with the specifications given in Table A5/2.

Table A5/2

Permissible zero and span response drift of analysers for measuring gaseous components under laboratory conditions

Pollutant	Absolute Zero response drift	Absolute Span response drift
CO_2	≤ 1000 ppm over 4 h	≤ 2 % of reading or ≤ 1000 ppm over 4 h, whichever is larger
CO	≤ 50 ppm over 4 h	≤ 2 % of reading or ≤ 50 ppm over 4 h, whichever is larger
PN	5 000 particles per cubic centimetre over 4 h	According to manufacturer specifications
NO_X	≤ 3 ppm over 4 h	≤ 2 % of reading or 3 ppm over 4 h, whichever is larger
CH_4	≤ 10 ppm C_1	≤ 2 % of reading or ≤ 10 ppm C_1 over 4 h, whichever is larger
THC	≤ 10 ppm C_1	≤ 2 % of reading or ≤ 10 ppm C_1 over 4 h, whichever is larger

4.2.7. *Rise time*

The rise time, defined as the time between the 10 per cent and 90 per cent response of the final reading (t_{10} to t_{90}; see paragraph 4.4.), shall not exceed 3 seconds.

4.2.8. *Gas drying*

Exhaust gases may be measured wet or dry. A gas-drying device, if used, shall have a minimal effect on the composition of the measured gases. Chemical dryers are not permitted.

4.3. **Additional requirements**

4.3.1. *General*

The provisions in paragraphs 4.3.2. to 4.3.5. define additional performance requirements for specific analyser types and apply only to cases in which the analyser under consideration is used for RDE emission measurements.

4.3.2. *Efficiency test for NO_X converters*

If a NO_X converter is applied, for example to convert NO_2 into NO for analysis with a chemiluminescence analyser, its efficiency shall be tested by following the requirements in paragraph 5.5. of Annex B5 to UN Regulation No 154. The efficiency of the NO_X converter shall be verified no longer than one month before the emissions test.

4.3.3. *Adjustment of the Flame Ionisation Detector (FID)*

(a) Optimization of the detector response

If hydrocarbons are measured, the FID shall be adjusted as specified by the instrument manufacturer. A propane-in-air or propane-in-nitrogen span gas shall be used to optimize the response in the most common operating range.

(b) Hydrocarbon response factors

If hydrocarbons are measured, the hydrocarbon response factor of the FID shall be verified by following the provisions of paragraph 5.4.3. of Annex B5 to UN Regulation No 154, using propane-in-air or propane-in-nitrogen as span gases and purified synthetic air or nitrogen as zero gases, respectively.

(c) Oxygen interference check

The oxygen interference check shall be performed when introducing a FID into service and after major maintenance intervals. A measuring range shall be chosen in which the oxygen interference check gases fall in the upper 50 per cent. The test shall be conducted with the oven temperature set as required. The specifications of the oxygen interference check gases are described in paragraph 5.3.

The following procedure applies:

(i) The analyser shall be set at zero;

(ii) The analyser shall be spanned with a 0 per cent oxygen blend for positive ignition engines and a 21 per cent oxygen blend for compression ignition engines;

(iii) The zero response shall be rechecked. If it has changed by more than 0.5 per cent of full scale, steps (i) and (ii) shall be repeated;

(iv) The 5 per cent and 10 per cent oxygen interference check gases shall be introduced;

(v) The zero response shall be rechecked. If it has changed by more than ±1 per cent of full scale, the test shall be repeated;

(vi) The oxygen interference E_{O2} [%] shall be calculated for each oxygen interference check gas in step (iv) as follows:

$$E_{O2} = \frac{(c_{ref,d} - c)}{c_{ref,d}} \times 100$$

where the analyser response is:

$$c = \frac{(c_{ref,d} \times c_{FS,b})}{c_{m,b}} \times \frac{c_{m,b}}{c_{FS,d}}$$

where:

$c_{ref,b}$		is the reference HC concentration in step (ii) [ppmC_1]
$c_{ref,d}$		is the reference HC concentration in step (iv) [ppmC_1]
$c_{FS,b}$		is the full scale HC concentration in step (ii) [ppmC_1]
$c_{FS,d}$		is the full scale HC concentration in step (iv) [ppmC_1]
$c_{m,b}$		is the measured HC concentration in step (ii) [ppmC_1]
$c_{m,d}$		is the measured HC concentration in step (iv) [ppmC_1]

(vii) The oxygen interference E_{O2} shall be less than ±1.5 per cent for all required oxygen interference check gases.

(viii) If the oxygen interference E_{O2} is higher than ±1.5 per cent, corrective action may be taken by incrementally adjusting the air flow (above and below the manufacturer's specifications), the fuel flow and the sample flow.

(ix) The oxygen interference check shall be repeated for each new setting.

4.3.4. Conversion efficiency of the non-methane cutter (NMC)

If hydrocarbons are analysed, a NMC can be used to remove non-methane hydrocarbons from the gas sample by oxidizing all hydrocarbons except methane. Ideally, the conversion for methane is 0 per cent and for the other hydrocarbons, represented by ethane, is 100 per cent. For the accurate measurement of NMHC, the two efficiencies shall be determined and used for the calculation of the NMHC emissions (see paragraph 6.2. of Appendix 7). It is not necessary to determine the methane conversion efficiency in the case where the NMC-FID is calibrated according to method (b) in paragraph 6.2. of Appendix 7 by passing the methane/air calibration gas through the NMC.

(a) Methane conversion efficiency

Methane calibration gas shall be flowed through the FID with and without bypassing the NMC; the two concentrations shall be recorded. The methane efficiency shall be determined as:

$$E_M = 1 - \frac{C_{HC(w/NMC)}}{C_{HC(w/o\ NMC)}}$$

where:

$c_{HC(w/NMC)}$		is the HC concentration with CH_4 flowing through the NMC [ppmC_1]
$c_{HC(w/o\ NMC)}$		is the HC concentration with CH_4 bypassing the NMC [ppmC_1]

(b) Ethane conversion efficiency

Ethane calibration gas shall be flowed through the FID with and without bypassing the NMC; the two concentrations shall be recorded. The ethane efficiency shall be determined as:

$$E_E = 1 - \frac{C_{HC(w/NMC)}}{C_{HC(w/o\ NMC)}}$$

where:

$c_{HC(w/NMC)}$		is the HC concentration with C_2H_6 flowing through the NMC [ppmC_1]
$c_{HC(w/o\ NMC)}$		is the HC concentration with C_2H_6 bypassing the NMC [ppmC_1]

4.3.5. *Interference effects*

(a) General

Other gases than the ones being analysed can affect the analyser reading. A check for interference effects and the correct functionality of analysers shall be performed by the analyser manufacturer prior to market introduction at least once for each type of analyser or device addressed in paragraphs 4.3.5. (b) to (f).

(b) CO analyser interference check

Water and CO_2 can interfere with the measurements of the CO analyser. Therefore, a CO_2 span gas, having a concentration of 80 to 100 per cent of the full scale of the maximum operating range of the CO_2 analyser used during the test, shall be bubbled through water at room temperature and the analyser response recorded. The analyser response shall not be more than 2 per cent of the mean CO concentration expected during normal on-road testing or ± 50 ppm, whichever is larger. The interference check for H_2O and CO_2 may be run as separate procedures. If the H_2O and CO_2 levels used for the interference

check are higher than the maximum levels expected during the test, each observed interference value shall be scaled down by multiplying the observed interference with the ratio of the maximum expected concentration value during the test and the actual concentration value used during this check. Separate interference checks with concentrations of H_2O that are lower than the maximum concentration expected during the test may be run and the observed H_2O interference shall be scaled up by multiplying the observed interference with the ratio of the maximum H_2O concentration value expected during the test and the actual concentration value used during this check. The sum of the two scaled interference values shall meet the tolerance specified in this point.

(c) NO_X analyser quench check

The two gases of concern for CLD and HCLD analysers are CO_2 and water vapour. The quench response to these gases is proportional to the gas concentrations. A test shall determine the quench at the highest concentrations expected during the test. If the CLD and HCLD analysers use quench compensation algorithms that utilize H_2O or CO_2 measurement analysers or both, quench shall be evaluated with these analysers active and with the compensation algorithms applied.

(i) CO_2 quench check

A CO_2 span gas having a concentration of 80 to 100 per cent of the maximum operating range shall be passed through the NDIR analyser; the CO_2 value shall be recorded as A. The CO_2 span gas shall then be diluted by approximately 50 per cent with NO span gas and passed through the NDIR and CLD or HCLD; the CO_2 and NO values shall be recorded as B and C, respectively. The CO_2 gas flow shall then be shut off and only the NO span gas shall be passed through the CLD or HCLD; the NO value shall be recorded as D. The per cent quench shall be calculated as:

$$E_{CO_2} = \left[1 - \left(\frac{C \times A}{(D \times A) - D \times B}\right)\right] \times 100$$

where:

A		is the undiluted CO_2 concentration measured with the NDIR [%]
B		is the diluted CO_2 concentration measured with the NDIR [%]
C		is the diluted NO concentration measured with the CLD or HCLD [ppm]
D		is the undiluted NO concentration measured with the CLD or HCLD [ppm]

Alternative methods of diluting and quantifying of CO_2 and NO span gas values such as dynamic mixing/blending are permitted upon approval of the approval authority.

(ii) Water quench check

This check applies to measurements of wet gas concentrations only. The calculation of water quench shall consider dilution of the NO span gas with water vapour and the scaling of the water vapour concentration in the gas mixture to concentration levels that are expected to occur during an emissions test. A NO span gas having a concentration of 80 per cent to 100 per cent of full scale of the normal operating range shall be passed through the CLD or HCLD; the NO value shall be recorded as *D*. The

NO span gas shall then be bubbled through water at room temperature and passed through the CLD or HCLD; the NO value shall be recorded as C_b. The analyser's absolute operating pressure and the water temperature shall be determined and recorded as E and F, respectively. The mixture's saturation vapour pressure that corresponds to the water temperature of the bubbler *F* shall be determined and recorded as *G*. The water vapour concentration *H* [%] of the gas mixture shall be calculated as:

$$H = \frac{G}{E} \times 100$$

The expected concentration of the diluted NO-water vapour span gas shall be recorded as D_e after being calculated as:

$$D_e = D \times \left(1 - \frac{H}{100}\right)$$

For diesel exhaust, the maximum concentration of water vapour in the exhaust gas (in per cent) expected during the test shall be recorded as H_m after being estimated, under the assumption of a fuel H/C ratio of 1.8/1, from the maximum CO_2 concentration in the exhaust gas A as follows:

$$H_m = 0{,}9 \times A$$

The per cent water quench shall be calculated as:

$$E_{H_2O} = \left(\frac{D_e - C_b}{D_e}\right) \times \left(\frac{H_m}{H}\right) \times 100$$

where:

D_e		is the expected diluted NO concentration [ppm]
C_b		is the measured diluted NO concentration [ppm]
H_m		is the maximum water vapour concentration [%]
H		is the actual water vapour concentration [%]

(iii) Maximum allowable quench

The combined CO_2 and water quench shall not exceed 2 per cent of full scale.

(d) Quench check for NDUV analysers

Hydrocarbons and water can positively interfere with NDUV analysers by causing a response similar to that of NO_X. The manufacturer of the NDUV analyser shall use the following procedure to verify that quench effects are limited:

(i) The analyser and chiller shall be set up by following the operating instructions of the manufacturer; adjustments should be made as to optimise the analyser and chiller performance.

(ii) A zero calibration and span calibration at concentration values expected during emissions testing shall be performed for the analyser.

(iii) A NO_2 calibration gas shall be selected that matches as far as possible the maximum NO_2 concentration expected during emissions testing.

(iv) The NO_2 calibration gas shall overflow at the gas sampling system's probe until the NO_X response of the analyser has stabilised.

(v) The mean concentration of the stabilized NO_X recordings over a period of 30 s shall be calculated and recorded as $NO_{X,ref}$.

(vi) The flow of the NO_2 calibration gas shall be stopped and the sampling system saturated by overflowing with a dew point generator's output, set at a dew point of 50 °C. The dew point generator's output shall be sampled through the sampling system and chiller for at least 10 minutes until the chiller is expected to be removing a constant rate of water.

(vii) Upon completion of (vi), the sampling system shall again be overflown by the NO_2 calibration gas used to establish $NO_{X,ref}$ until the total NO_X response has stabilized.

(viii) The mean concentration of the stabilized NO_X recordings over a period of 30 s shall be calculated and recorded as $NO_{X,m}$.

(ix) $NO_{X,m}$ shall be corrected to $NO_{X,dry}$ based upon the residual water vapour that passed through the chiller at the chiller's outlet temperature and pressure.

The calculated $NO_{X,dry}$ shall at least amount to 95 % of $NO_{X,ref}$.

(e) Sample dryer

A sample dryer removes water, which can otherwise interfere with the NO_X measurement. For dry CLD analysers, it shall be demonstrated that at the highest expected water vapour concentration H_m the sample dryer maintains the CLD humidity at ≤ 5 g water/kg dry air (or about 0.8 per cent H_2O), which is 100 per cent relative humidity at 3.9 °C and 101.3 kPa or about 25 per cent relative humidity at 25 °C and 101.3 kPa. Compliance may be demonstrated by measuring the temperature at the outlet of a thermal sample dryer or by measuring the humidity at a point just upstream of the CLD. The humidity of the CLD exhaust might also be measured as long as the only flow into the CLD is the flow from the sample dryer.

(f) Sample dryer NO_2 penetration

Liquid water remaining in an improperly designed sample dryer can remove NO_2 from the sample. If a sample dryer is used in combination with a NDUV analyser without an NO_2/NO converter upstream, water could therefore remove NO_2 from the sample prior to the NO_X measurement. The sample dryer shall allow for measuring at least 95 per cent of the NO_2 contained in a gas that is saturated with water vapour and consists of the maximum NO_2 concentration expected to occur during emission testing.

4.4. **Response time check of the analytical system**

For the response time check, the settings of the analytical system shall be exactly the same as during the emissions test (i.e. pressure, flow rates, filter settings in the analysers and all other parameters influencing the response time). The response time shall be determined with gas switching directly at the inlet of the sample probe. The gas switching shall be done in less than 0.1 second. The gases used for the test shall cause a concentration change of at least 60 per cent full scale of the analyser.

The concentration trace of each single gas component shall be recorded.

For time alignment of the analyser and exhaust flow signals, the transformation time is defined as the time from the change (t_0) until the response is 50 per cent of the final reading (t_{50}).

The system response time shall be ≤ 12 s with a rise time of ≤ 3 seconds for all components and all ranges used. When using a NMC for the measurement of NMHC, the system response time may exceed 12 seconds.

5. GASES

5.1. **Calibration and span gases for RDE tests**

5.1.1. *General*

The shelf life of calibration and span gases shall be respected. Pure as well as mixed calibration and span gases shall fulfil the specifications of Annex B5 of UN Regulation No 154.

5.1.2. *NO_2 calibration gas*

In addition, NO_2 calibration gas is permissible. The concentration of the NO_2 calibration gas shall be within two per cent of the declared concentration value. The amount of NO contained in the NO_2 calibration gas shall not exceed 5 per cent of the NO_2 content.

5.1.3. *Multicomponent mixtures*

Only multicomponent mixtures which fulfil the requirements of paragraph 5.1.1. shall be used. These mixtures may contain two or more of the components. Multicomponent mixtures containing both NO and NO_2 are exempted of the NO_2 impurity requirement set out in paragraphs 5.1.1. and 5.1.2.

5.2. **Gas dividers**

Gas dividers (i.e., precision blending devices that dilute with purified N_2 or synthetic air) can be used to obtain calibration and span gases. The accuracy of the gas divider shall be such that the concentration of the blended calibration gases is accurate to within ± 2 per cent. The verification shall be performed at between 15 and 50 per cent of full scale for each calibration incorporating a gas divider. An additional verification may be performed using another calibration gas, if the first verification has failed.

Optionally, the gas divider may be checked with an instrument which by nature is linear, e.g. using NO gas in combination with a CLD. The span value of the instrument shall be adjusted with the span gas directly connected to the instrument. The gas divider shall be checked at the settings typically used and the nominal value shall be compared with the concentration measured by the instrument. The difference shall in each point be within ±1 per cent of the nominal concentration value.

5.3. **Oxygen interference check gases**

Oxygen interference check gases consist of a blend of propane, oxygen and nitrogen and shall contain propane at a concentration of 350 ± 75 ppmC_1. The concentration shall be determined by gravimetric methods, dynamic blending or the chromatographic analysis of total hydrocarbons plus impurities. The oxygen concentrations of the oxygen interference check gases shall meet the requirements listed in Table A5/3; the remainder of the oxygen interference check gas shall consist of purified nitrogen.

Table A5/3

Oxygen interference check gases

	Engine type	
	Compression ignition	Positive ignition
O_2 concentration	21 ± 1 %	10 ± 1 %
	10 ± 1 %	5 ± 1 %
	5 ± 1 %	0,5 ± 0,5 %

6. ANALYSERS FOR MEASURING (SOLID) PARTICLE EMISSIONS

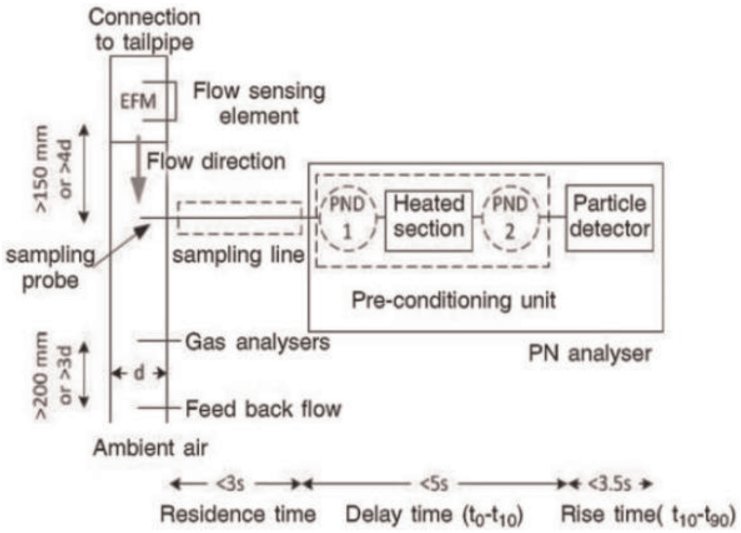
This section will define future requirement for analysers for measuring particle number emissions, once their measurement becomes mandatory.

6.1. **General**

The PN analyser shall consist of a pre-conditioning unit and a particle detector that counts with 50 per cent efficiency from approximately 23 nm. It is permissible that the particle detector also pre-conditions the aerosol. The sensitivity of the analysers to shocks, vibration, aging, variability in temperature and air pressure as well as electromagnetic interferences and other impacts related to vehicle and analyser operation shall be limited as far as possible and shall be clearly stated by the equipment manufacturer in its support material. The PN analyser shall only be used within its manufacturer's declared parameters of operation. An example of a PN analyser setup is provided in Figure A5/1.

Figure A5/1

Example of a PN analyser setup: Dotted lines depict optional parts. EFM = Exhaust mass Flow Meter, d = inner diameter, PND = Particle Number Diluter



The PN analyser shall be connected to the sampling point via a sampling probe which extracts a sample from the centreline of the tailpipe tube. As specified in paragraph 3.5. of Appendix 4, if particles are not diluted at the tailpipe, the sampling line shall be heated to a minimum temperature of 373 K (100 °C) until the point of first dilution of the PN analyser or the particle detector of the analyser. The residence time in the sampling line shall be less than 3 s.

All parts in contact with the sampled exhaust gas shall be always kept at a temperature that avoids condensation of any compound in the device. This can be achieved for example by heating at a higher temperature and diluting the sample or oxidizing the (semi)volatile species.

The PN analyser shall include a heated section at wall temperature ≥ 573 K. The unit shall control the heated stages to constant nominal operating temperatures, within a tolerance of ± 10 K, and provide an indication of whether or not heated stages are at their correct operating temperatures. Lower temperatures are acceptable as long as the volatile particle removal efficiency fulfils the specifications of paragraph 6.4.

Pressure, temperature and other sensors shall monitor the proper operation of the instrument during operation and trigger a warning or message in case of malfunction.

The delay time of the PN analyser shall be ≤ 5 s.

The PN analyser (and/or particle detector) shall have a rise time of ≤ 3.5 s.

Particle concentration measurements shall be reported normalised to 273 K and 101.3 kPa. If necessary, the pressure and/or temperature at the inlet of the detector shall be measured and reported for the purposes of normalizing the particle concentration.

PN systems that comply with the calibration requirements of UN Regulation No 154 automatically comply with the calibration requirements of this appendix.

6.2. **Efficiency requirements**

The complete PN analyser system including the sampling line shall fulfil the efficiency requirements of Table A5/3a.

Table A5/3a

PN analyser (including the sampling line) system efficiency requirements

d_p [nm]	Sub-23	23	30	50	70	100	200
$E(d_p)$ PN analyser	To be determined	0,2 – 0,6	0,3 – 1,2	0,6 – 1,3	0,7 – 1,3	0,7 – 1,3	0,5 – 2,0

Efficiency $E(d_p)$ is defined as the ratio in the readings of the PN analyser system to a reference Condensation Particle Counter (CPC)'s ($d_{50\,\%}$ = 10 nm or lower, checked for linearity and calibrated with an electrometer) or an Electrometer's number concentration measuring in parallel monodisperse aerosol of mobility diameter d_p and normalized at the same temperature and pressure conditions.

The material should be thermally stable soot-like (e.g. spark discharged graphite or diffusion flame soot with thermal pre-treatment). If the efficiency curve is measured with a different aerosol (e.g. NaCl), the correlation to the soot-like curve must be provided as a chart which compares the efficiencies obtained using both test aerosols. The differences in the counting efficiencies shall be taken into account by adjusting the measured efficiencies based on the provided chart to give soot-like aerosol efficiencies. The correction for multiply charged particles shall be applied and documented but shall not exceed 10 %. These efficiencies refer to the PN analysers with the sampling line. The PN analyser can also be calibrated in parts (i.e. the pre-conditioning unit separately from the particle detector) as long as it is proven that the PN analyser and the sampling line together fulfil the requirements of Table A5/3a. The measured signal from the detector shall be > 2 times the limit of detection (here defined as the zero level plus 3 standard deviations).

6.3. **Linearity requirements**

The PN analyser including the sampling line shall fulfil the linearity requirements of paragraph 3.2. of Appendix 5 using monodisperse or polydisperse soot-like particles. The particle size (mobility diameter or count median diameter) shall be larger than 45 nm. The reference instrument shall be an Electrometer or a Condensation Particle Counter (CPC) with d_{50} = 10 nm or lower, verified for linearity. Alternatively, a particle number system compliant with UN Regulation No 154.

In addition, the differences of the PN analyser from the reference instrument at all points checked (except the zero point) shall be within 15 % of their mean value. At least 5 points equally distributed (plus the zero) shall be checked. The maximum checked concentration shall be >90 % of the PN analyser nominal measurement range.

If the PN analyser is calibrated in parts, then the linearity can be checked only for the PN detector, but the efficiencies of the rest parts and the sampling line shall be considered in the slope calculation.

6.4. **Volatile removal efficiency**

The system shall achieve > 99 % removal of ≥ 30 nm tetracontane ($CH_3(CH_2)_{38}CH_3$) particles with an inlet concentration of ≥ 10000 particles per cubic-centimetre at the minimum dilution.

The system shall also achieve a > 99 % removal efficiency of tetracontane with count median diameter > 50 nm and mass > 1 mg/m^3.

The volatile removal efficiency with tetracontane shall be proven only once for the instrument family. The instrument manufacturer though shall provide the maintenance or replacement interval that ensures that the removal efficiency does not drop below the technical requirements. If such information is not provided, the volatile removal efficiency shall be checked yearly for each instrument.

7. INSTRUMENTS FOR MEASURING EXHAUST MASS FLOW

7.1. **General**

Instruments or signals for measuring the exhaust mass flow rate shall have a measuring range and response time appropriate for the accuracy required to measure the exhaust mass flow rate under transient and steady state conditions. The sensitivity of instruments and signals to shocks, vibration, aging, variability in temperature, ambient air pressure, electromagnetic interferences and other impacts related to vehicle and instrument operation shall be on a level as to eliminate additional errors.

7.2. **Instrument specifications**

The exhaust mass flow rate shall be determined by a direct measurement method applied in either of the following instruments:

(a) Pitot-based flow devices;

(b) Pressure differential devices like flow nozzle (details see ISO 5167);

(c) Ultrasonic flow meter;

(d) Vortex flow meter.

Each individual exhaust mass flow meter shall fulfil the linearity requirements set out in paragraph 3. Furthermore, the instrument manufacturer shall demonstrate the compliance of each type of exhaust mass flow meter with the specifications in paragraphs 7.2.3. to 7.2.9.

It is permissible to calculate the exhaust mass flow rate based on air flow and fuel flow measurements obtained from sensors with traceable calibration if these fulfil the linearity requirements of paragraph 3., the accuracy requirements of paragraph 8. and if the resulting exhaust mass flow rate is validated according to paragraph 4. of Appendix 6.

In addition, other methods that determine the exhaust mass flow rate based on non-traceable instruments and signals, such as simplified exhaust mass flow meters or ECU signals, are permissible if the resulting exhaust mass flow rate fulfils the linearity requirements of paragraph 3. and is validated according to paragraph 4. of Appendix 6.

7.2.1. *Calibration and verification standards*

The measurement performance of exhaust mass flow meters shall be verified with air or exhaust gas against a traceable standard such as a calibrated exhaust mass flow meter or a full flow dilution tunnel.

7.2.2. *Frequency of verification*

The compliance of exhaust mass flow meters with paragraphs 7.2.3. to 7.2.9. shall be verified no longer than one year before the actual test.

7.2.3. *Accuracy*

The accuracy of the EFM, defined as the deviation of the EFM reading from the reference flow value, shall not exceed ± 3 percent of the reading, or 0.3 % of full scale, whichever is larger.

7.2.4. *Precision*

The precision, defined as 2.5 times the standard deviation of 10 repetitive responses to a given nominal flow, approximately in the middle of the calibration range, shall not exceed 1 per cent of the maximum flow at which the EFM has been calibrated.

7.2.5. *Noise*

The noise shall not exceed 2 per cent of the maximum calibrated flow value. Each of the 10 measurement periods shall be interspersed with an interval of 30 seconds in which the EFM is exposed to the maximum calibrated flow.

7.2.6. *Zero response drift*

The zero response drift is defined as the mean response to zero flow during a time interval of at least 30 seconds. The zero response drift can be verified based on the reported primary signals, e.g., pressure. The drift of the primary signals over a period of 4 hours shall be less than ±2 per cent of the maximum value of the primary signal recorded at the flow at which the EFM was calibrated.

7.2.7. *Span response drift*

The span response drift is defined as the mean response to a span flow during a time interval of at least 30 seconds. The span response drift can be verified based on the reported primary signals, e.g., pressure. The drift of the primary signals over a period of 4 hours shall be less than ± 2 per cent of the maximum value of the primary signal recorded at the flow at which the EFM was calibrated.

7.2.8. *Rise time*

The rise time of the exhaust flow instruments and methods should match as far as possible the rise time of the gas analysers as specified in paragraph 4.2.7. but shall not exceed 1 second.

7.2.9. *Response time check*

The response time of exhaust mass flow meters shall be determined by applying similar parameters as those applied for the emissions test (i.e., pressure, flow rates, filter settings and all other response time influences). The response time determination shall be done with gas switching directly at the inlet of the exhaust mass flow meter. The gas flow switching shall be done as fast as possible, but in less than 0.1 second is highly recommended. The gas flow rate used for the test shall cause a flow rate change of at least 60 per cent full scale of the exhaust mass flow meter. The gas flow shall be recorded. The delay time is defined as the time from the gas flow switching (t_0) until the response is 10 per cent (t_{10}) of the final reading. The rise time is defined as the time between 10 per cent and 90 per cent response (t_{10} to t_{90}) of the final reading. The response time (t_{90}) is defined as the sum of the delay time and the rise time. The exhaust mass flow meter response time (t_{90}) shall be ≤ 3 seconds with a rise time (t_{10} to t_{90}) of ≤ 1 second in accordance with paragraph 7.2.8.

8. SENSORS AND AUXILIARY EQUIPMENT

Any sensor or auxiliary equipment used to determine temperature, atmospheric pressure, ambient humidity, vehicle speed, fuel flow or intake air flow, for example, shall not alter or unduly affect the performance of the vehicle's engine and exhaust after-treatment system. The accuracy of sensors and auxiliary equipment shall fulfil the requirements of Table A5/4. Compliance with the requirements of Table A5/4 shall be demonstrated at intervals specified by the instrument manufacturer, as required by internal audit procedures or in accordance with ISO 9000.

Table A5/4

Accuracy requirements for measurement parameters

Measurement parameter	Accuracy
Fuel flow ([21])	± 1 % of reading ([22])
Air flow ([23])	± 2 % of reading
Vehicle speed ([24])	± 1,0 km/h absolute
Temperatures ≤ 600 K	± 2 K absolute
Temperatures > 600 K	± 0,4 % of reading in Kelvin
Ambient pressure	± 0,2 kPa absolute
Relative humidity	± 5 % absolute
Absolute humidity	± 10 % of reading or, 1 gH_2O/kg dry air, whichever is larger

([21]) Optional to determine exhaust mass flow.
([22]) The accuracy shall be 0.02 per cent of reading if used to calculate the air and exhaust mass flow rate from the fuel flow according to paragraph 7 of Appendix 7.
([23]) Optional to determine exhaust mass flow.
([24]) This requirement applies to the speed sensor only; if vehicle speed is used to determine parameters like acceleration, the product of speed and positive acceleration, or RPA, the speed signal shall have an accuracy of 0.1 % above 3 km/h and a sampling frequency of 1 Hz. This accuracy requirement can be met by using a wheel rotational speed signal.

Appendix 6

Validation of PEMS and non-traceable exhaust mass flow rate

1. INTRODUCTION

This appendix describes the requirements to validate under transient conditions the functionality of the installed PEMS as well as the correctness of the exhaust mass flow rate obtained from non-traceable exhaust mass flow meters or calculated from ECU signals.

2. SYMBOLS, PARAMETERS AND UNITS

a_0	—	y intercept of the regression line
a_1	—	slope of the regression line
r^2	—	coefficient of determination
x	—	actual value of the reference signal
y	—	actual value of the signal under validation

3. VALIDATION PROCEDURE FOR PEMS

3.1. **Frequency of PEMS validation**

It is recommended to validate the correct installation of a PEMS on a vehicle via comparison with laboratory installed equipment on a test performed on a chassis dynamometer either before the RDE test or, alternatively, after the completion of the test. For tests performed during type approval, the validation test is required.

3.2. **PEMS validation procedure**

3.2.1. *PEMS installation*

The PEMS shall be installed and prepared according to the requirements of Appendix 4. The PEMS installation shall be kept unchanged in the time period between the validation and the RDE test.

3.2.2. *Test conditions*

The validation test shall be conducted on a chassis dynamometer, as far as possible, under type approval conditions by following the requirements of UN Regulation No 154. It is recommended to feed the exhaust flow extracted by the PEMS during the validation test back to the CVS. If this is not feasible, the CVS results shall be corrected for the extracted exhaust mass. If the exhaust mass flow rate is validated with an exhaust mass flow meter, it is recommended to cross-check the mass flow rate measurements with data obtained from a sensor or the ECU.

3.2.3. *Data analysis*

The total distance-specific emissions [g/km] measured with laboratory equipment shall be calculated in accordance with UN Regulation No 154. The emissions as measured with the PEMS shall be calculated according to Appendix 7, summed to give the total mass of pollutants [g] and then divided by the test distance [km] as obtained from the chassis dynamometer. The total distance-specific mass of pollutants [g/km], as determined by the PEMS and the reference laboratory system, shall be evaluated against the requirements specified in paragraph 3.3. For the validation of NO_X emission measurements, humidity correction shall be applied in accordance with UN Regulation No 154.

3.3. **Permissible tolerances for PEMS validation**

The PEMS validation results shall fulfil the requirements given in Table A6/1. If any permissible tolerance is not met, corrective action shall be taken and the PEMS validation shall be repeated.

Table A6/1

Permissible tolerances

Parameter [Unit]	Permissible absolute tolerance
Distance [km] ([25])	250 m of the laboratory reference
THC ([26]) [mg/km]	15 mg/km or 15 % of the laboratory reference, whichever is larger
CH_4 ([25]) [mg/km]	15 mg/km or 15 % of the laboratory reference, whichever is larger
NMHC ([25]) [mg/km]	20 mg/km or 20 % of the laboratory reference, whichever is larger
PN ([25]) [#/km]	$8 \cdot 10^{10}$ p/km or 42 % of the laboratory reference ([27]) whichever is larger
CO ([25]) [mg/km]	100 mg/km or 15 % of the laboratory reference, whichever is larger
CO_2 [g/km]	10 g/km or 7,5 % of the laboratory reference, whichever is larger
NO_x ([25]) [mg/km]	10 mg/km or 12,5 % of the laboratory reference, whichever is larger

4. VALIDATION PROCEDURE FOR THE EXHAUST MASS FLOW RATE DETERMINED BY NON-TRACEABLE INSTRUMENTS AND SENSORS

4.1. **Frequency of validation**

In addition to fulfilling the linearity requirements of paragraph 3. of Appendix 5 under steady-state conditions, the linearity of non-traceable exhaust mass flow meters or the exhaust mass flow rate calculated from non-traceable sensors or ECU signals shall be validated under transient conditions for each test vehicle against a calibrated exhaust mass flow meter or the CVS.

4.2. **Validation procedure**

The validation shall be conducted on a chassis dynamometer under type approval conditions, as far as applicable on the same vehicle used for the RDE test. As reference, a flow meter with traceable calibration shall be used. The ambient temperature can be any within the range specified in paragraph 5.1. of this Annex. The installation of the exhaust mass flow meter and the execution of the test shall fulfil the requirement of paragraph 3.4.3. of Appendix 4.

The following calculation steps shall be taken to validate the linearity:

(a) The signal under validation and the reference signal shall be time corrected by following, as far as applicable, the requirements of paragraph 3. of Appendix 7.

(b) Points below 10 % of the maximum flow value shall be excluded from the further analysis.

(c) At a constant frequency of at least 1.0 Hz, the signal under validation and the reference signal shall be correlated using the best-fit equation having the form:

$$y = a_1 x + a_0$$

([25]) Only applicable if vehicle speed is determined by the ECU; to meet the permissible tolerance it is permitted to adjust the ECU vehicle speed measurements based on the outcome of the validation test.
([26]) Parameter only mandatory if measurement required for compliance with the limits.
([27]) PMP system.

where:

y		is the actual value of the signal under validation
a_1		is the slope of the regression line
x		is the actual value of the reference signal
a_0		is the y intercept of the regression line

The standard error of estimate (*SEE*) of y on x and the coefficient of determination (r^2) shall be calculated for each measurement parameter and system.

(d) The linear regression parameters shall meet the requirements specified in Table A6/2.

4.3. **Requirements**

The linearity requirements given in Table A6/2 shall be fulfilled. If any permissible tolerance is not met, corrective action shall be taken and the validation shall be repeated.

Table A6/2

Linearity requirements of calculated and measured exhaust mass flow

Measurement parameter/ system	a_0	Slope a_1	Standard error of the estimate *SEE*	Coefficient of determination r^2
Exhaust mass flow	0,0 ± 3,0 kg/h	1,00 ± 0,075	≤ 10 % max	≥ 0,90

Appendix 7

Determination of instantaneous emissions

1. INTRODUCTION

This appendix describes the procedure to determine the instantaneous mass and particle number emissions [g/s; #/s], following application of the data consistency rules of Appendix 4. The instantaneous mass and particle number emissions shall then be used for the subsequent evaluation of a RDE trip and the calculation of the intermediate and final emission result as described in Appendix 11.

2. SYMBOLS, PARAMETERS AND UNITS

α	—	molar hydrogen ratio (H/C)
β	—	molar carbon ratio (C/C)
γ	—	molar sulphur ratio (S/C)
δ	—	molar nitrogen ratio (N/C)
$\Delta t_{t,i}$	—	transformation time t of the analyser [s]
$\Delta t_{t,m}$	—	transformation time t of the exhaust mass flow meter [s]
ε	—	molar oxygen ratio (O/C)
ρ_e	—	density of the exhaust
ρ_{gas}	—	density of the exhaust component 'gas'
λ	—	excess air ratio
λ_i	—	instantaneous excess air ratio
A/F_{st}	—	stoichiometric air-to-fuel ratio [kg/kg]
c_{CH4}	—	concentration of methane
c_{CO}	—	dry CO concentration [%]
c_{CO_2}	—	dry CO_2 concentration [%]
c_{dry}	—	dry concentration of a pollutant in ppm or per cent volume
$c_{gas,i}$	—	instantaneous concentration of the exhaust component 'gas' [ppm]
c_{HCw}	—	wet HC concentration [ppm]
$c_{HC(w/NMC)}$	—	HC concentration with CH_4 or C_2H_6 flowing through the NMC [ppmC_1]
$c_{HC(w/oNMC)}$	—	HC concentration with CH_4 or C_2H_6 bypassing the NMC [ppmC_1]
$c_{i,c}$	—	time-corrected concentration of component *i* [ppm]
$c_{i,r}$	—	concentration of component *i* [ppm] in the exhaust

c_{NMHC}	—	concentration of non-methane hydrocarbons
c_{wet}	—	wet concentration of a pollutant in ppm or per cent volume
E_E	—	ethane efficiency
E_M	—	methane efficiency
H_a	—	intake air humidity [g water per kg dry air]
i	—	number of the measurement
$m_{gas,i}$	—	mass of the exhaust component 'gas' [g/s]
$q_{maw,i}$	—	instantaneous intake air mass flow rate [kg/s]
$q_{m,c}$	—	time-corrected exhaust mass flow rate [kg/s]
$q_{mew,i}$	—	instantaneous exhaust mass flow rate [kg/s]
$q_{mf,i}$	—	instantaneous fuel mass flow rate [kg/s]
$q_{m,r}$	—	raw exhaust mass flow rate [kg/s]
r	—	cross-correlation coefficient
r^2	—	coefficient of determination
r_h	—	hydrocarbon response factor
u_{gas}	—	u value of the exhaust component 'gas'

3. TIME CORRECTION OF PARAMETERS

For the correct calculation of distance-specific emissions, the recorded traces of component concentrations, exhaust mass flow rate, vehicle speed, and other vehicle data shall be time corrected. To facilitate the time correction, data which are subject to time alignment shall be recorded either in a single data recording device or with a synchronised timestamp following paragraph 5.1. of Appendix 4. The time correction and alignment of parameters shall be carried out by following the sequence described in paragraphs 3.1. to 3.3.

3.1. **Time correction of component concentrations**

The recorded traces of all component concentrations shall be time corrected by reverse shifting according to the transformation times of the respective analysers. The transformation time of analysers shall be determined according to paragraph 4.4. of Appendix 5.:

$$c_{i,c}(t - \Delta t_{t,i}) = c_{i,r}(t)$$

where:

$c_{i,c}$		is the time-corrected concentration of component i as function of time t
$c_{i,r}$		is the raw concentration of component i as function of time t
$\Delta t_{t,i}$		is the transformation time t of the analyser measuring component i

3.2. **Time correction of exhaust mass flow rate**

The exhaust mass flow rate measured with an exhaust flow meter shall be time corrected by reverse shifting according to the transformation time of the exhaust mass flow meter. The transformation time of the mass flow meter shall be determined according to paragraph 4.4. of Appendix 5.:

$$q_{m,c}(t - \Delta t_{t,m}) = q_{m,r}(t)$$

where:

$q_{m,c}$		is the time-corrected exhaust mass flow rate as function of time t
$q_{m,r}$		is the raw exhaust mass flow rate as function of time t
$\Delta t_{t,m}$		is the transformation time t of the exhaust mass flow meter

In case the exhaust mass flow rate is determined by ECU data or a sensor, an additional transformation time shall be considered and obtained by cross-correlation between the calculated exhaust mass flow rate and the exhaust mass flow rate measured following paragraph 4. of Appendix 6.

3.3. **Time alignment of vehicle data**

Other data obtained from a sensor or the ECU shall be time-aligned by cross-correlation with suitable emission data (e.g., component concentrations).

3.3.1. *Vehicle speed from different sources*

To time align vehicle speed with the exhaust mass flow rate, it is first necessary to establish one valid speed trace. In case vehicle speed is obtained from multiple sources (e.g., the GNSS, a sensor or the ECU), the speed values shall be time aligned by cross-correlation.

3.3.2. *Vehicle speed with exhaust mass flow rate*

Vehicle speed shall be time aligned with the exhaust mass flow rate by cross-correlation between the exhaust mass flow rate and the product of vehicle speed and positive acceleration.

3.3.3. *Further signals*

The time alignment of signals whose values change slowly and within a small value range, e.g. ambient temperature, can be omitted.

4. EMISSION MEASUREMENTS DURING STOP OF THE COMBUSTION ENGINE

Any instantaneous emissions or exhaust flow measurements obtained while the combustion engine is deactivated shall be recorded in the data exchange file.

5. CORRECTION OF MEASURED VALUES

5.1. **Drift correction**

$$C_{cor} = C_{ref,z} + (C_{ref,s} + C_{ref,z})\left(\frac{2C_{gas} - (C_{pre,z} + C_{post,z})}{(C_{pre,s} + C_{post,s}) - (C_{pre,z} + C_{post,z})}\right)$$

$c_{ref,z}$		is the reference concentration of the zero gas (usually zero) [ppm]
$c_{ref,s}$		is the reference concentration of the span gas [ppm]
$c_{pre,z}$		is the pre-test analyser concentration of the zero gas [ppm]
$c_{pre,s}$		is the pre-test analyser concentration of the span gas [ppm]
$c_{post,z}$		is the post-test analyser concentration of the zero gas [ppm]
$c_{post,s}$		is the post-test analyser concentration of the span gas [ppm]
c_{gas}		is the sample gas concentration [ppm]

5.2. **Dry-wet correction**

If the emissions are measured on a dry basis, the measured concentrations shall be converted to a wet basis as:

$$c_{wet} = k_w \times c_{dry}$$

where:

c_{wet}		is the wet concentration of a pollutant in ppm or per cent volume
c_{dry}		is the dry concentration of a pollutant in ppm or per cent volume
k_w		is the dry-wet correction factor

The following equation shall be used to calculate k_w:

$$k_w = \left(\frac{1}{1 + \alpha \times 0{,}005 \times (c_{co_2} + c_{co})} - k_{w1}\right) \times 1{,}008$$

where:

$$k_{w1} = \frac{1{,}608 \times H_a}{1\,000 + (1{,}608 \times H_a)}$$

where:

H_a		is the intake air humidity [g water per kg dry air]
c_{CO_2}		is the dry CO_2 concentration [%]
c_{CO}		is the dry CO concentration [%]
α		is the molar hydrogen ratio of the fuel (H/C)

5.3. **Correction of NO_x for ambient humidity and temperature**

NO_x emissions shall not be corrected for ambient temperature and humidity.

5.4. **Correction of negative emission results**

Negative instantaneous results shall not be corrected.

6. DETERMINATION OF THE INSTANTANEOUS GASEOUS EXHAUST COMPONENTS

6.1. **Introduction**

The components in the raw exhaust shall be measured with the measurement and sampling analysers described in Appendix 5. The raw concentrations of relevant components shall be measured in accordance with Appendix 4. The data shall be time corrected and aligned in accordance with paragraph 3.

6.2. **Calculating NMHC and CH_4 concentrations**

For methane measurement using a NMC-FID, the calculation of NMHC depends on the calibration gas/method used for the zero/span calibration adjustment. When a FID is used for THC measurement without a NMC, it shall be calibrated with propane/air or propane/N_2 in the normal manner. For the calibration of the FID in series with a NMC, the following methods are permitted:

(a) the calibration gas consisting of propane/air bypasses the NMC;

(b) the calibration gas consisting of methane/air passes through the NMC.

It is strongly recommended to calibrate the methane FID with methane/air through the NMC.

In method (a), the concentrations of CH_4 and NMHC shall be calculated as follows:

$$C_{CH_4} = \frac{C_{HC(w/o\ NMC)} \times (1 - E_M) - C_{HC(w/NMC)}}{E_E - E_M}$$

$$C_{NMHC} = \frac{C_{HC(w/NMC)} - C_{HC(w/o\ NMC)} \times (1 - E_E)}{r_h \times (E_E - E_M)}$$

In method (b), the concentration of CH_4 and NMHC shall be calculated as follows:

$$C_{CH_4} = \frac{C_{HC(w/NMC)} \times r_h \times (1 - E_M) - C_{HC(w/o\ NMC)} \times (1 - E_E)}{r_h \times E_E - E_M}$$

$$C_{NMHC} = \frac{C_{HC(w/o\ NMC)} \times (1 - E_M) - C_{HC(w/NMC)} \times r_h \times (1 - E_M)}{(E_E - E_M)}$$

where:

$c_{HC(w/oNMC)}$		is the HC concentration with CH_4 or C_2H_6 bypassing the NMC [ppmC_1]
$c_{HC(w/NMC)}$		is the HC concentration with CH_4 or C_2H_6 flowing through the NMC [ppmC_1]
r_h		is the hydrocarbon response factor as determined in paragraph 4.3.3.(b) of Appendix 5
E_M		is the methane efficiency as determined in paragraph 4.3.4.(a) of Appendix 5
E_E		is the ethane efficiency as determined in paragraph 4.3.4.(b) of Appendix 5

If the methane FID is calibrated through the cutter (method b), then the methane conversion efficiency as determined in paragraph 4.3.4.(a) of Appendix 5 is zero. The density used for calculating the NMHC mass shall be equal to that of total hydrocarbons at 273.15 K and 101.325 kPa and is fuel-dependent.

7. DETERMINATION OF EXHAUST MASS FLOW RATE

7.1. **Introduction**

The calculation of instantaneous mass emissions according to paragraphs 8. and 9. requires determining the exhaust mass flow rate. The exhaust mass flow rate shall be determined by one of the direct measurement methods specified in paragraph 7.2. of Appendix 5. Alternatively, it is permissible to calculate the exhaust mass flow rate as described in paragraphs 7.2. to 7.4 of this Appendix.

7.2. **Calculation method using air mass flow rate and fuel mass flow rate**

The instantaneous exhaust mass flow rate can be calculated from the air mass flow rate and the fuel mass flow rate as follows:

$$q_{mew,i} = q_{maw,i} + q_{mf,i}$$

where:

$q_{mew,i}$		is the instantaneous exhaust mass flow rate [kg/s]
$q_{maw,i}$		is the instantaneous intake air mass flow rate [kg/s]
$q_{mf,i}$		is the instantaneous fuel mass flow rate [kg/s]

If the air mass flow rate and the fuel mass flow rate or the exhaust mass flow rate are determined from ECU recording, the calculated instantaneous exhaust mass flow rate shall meet the linearity requirements specified for the exhaust mass flow rate in paragraph 3. of Appendix 5 and the validation requirements specified in paragraph 4.3. of Appendix 6.

7.3. **Calculation method using air mass flow and air-to-fuel ratio**

The instantaneous exhaust mass flow rate can be calculated from the air mass flow rate and the air-to-fuel ratio as follows:

$$q_{mew,i} = q_{maw,i} \times \left(1 + \frac{1}{A/F_{st} \times l_i}\right)$$

where:

$$A/F_{st} = \frac{138{,}0 \times \left(1 + \frac{\alpha}{4} - \frac{\varepsilon}{2} + \gamma\right)}{12{,}011 + 1{,}008 \times \alpha + 15{,}999 \times \varepsilon + 14{,}0067 \times \gamma}$$

$$l_i = \frac{\left(100 - \frac{C_{CO} \times 10^{-4}}{2} - C_{HCw} \times 10^{-4}\right) + \left(\frac{\alpha}{4} \times \frac{1 - \frac{2 \times C_{CO} \times 10^{-4}}{3{,}5 \times C_{CO_2}}}{1 + \frac{C_{CO} \times 10^{-4}}{3{,}5 \times C_{CO_2}}} - \frac{\varepsilon}{4} - \frac{\gamma}{4}\right) \times (C_{CO_2} + C_{CO} \times 10^{-4})}{4{,}764 \times \left(1 + \frac{\alpha}{4} - \frac{\varepsilon}{2} + \gamma\right) \times (C_{CO_2} + C_{CO} \times 10^{-4} + C_{HCw} \times 10^{-4})}$$

where:

$q_{maw,i}$		is the instantaneous intake air mass flow rate [kg/s]
A/F_{st}		is the stoichiometric air-to-fuel ratio [kg/kg]
λ_i		is the instantaneous excess air ratio
c_{CO_2}		is the dry CO_2 concentration [%]
c_{CO}		is the dry CO concentration [ppm]
c_{HCw}		is the wet HC concentration [ppm]
α		is the molar hydrogen ratio (H/C)
β		is the molar carbon ratio (C/C)
γ		is the molar sulphur ratio (S/C)
δ		is the molar nitrogen ratio (N/C)
ε		is the molar oxygen ratio (O/C)

Coefficients refer to a fuel $C_\beta H_\alpha O_\varepsilon N_\delta S_\gamma$ with $\beta = 1$ for carbon based fuels. The concentration of HC emissions is typically low and may be omitted when calculating λ_i.

If the air mass flow rate and air-to-fuel ratio are determined from ECU recording, the calculated instantaneous exhaust mass flow rate shall meet the linearity requirements specified for the exhaust mass flow rate in paragraph 3. of Appendix 5 and the validation requirements specified in paragraph 4.3. of Appendix 6.

7.4. **Calculation method using fuel mass flow and air-to-fuel ratio**

The instantaneous exhaust mass flow rate can be calculated from the fuel flow and the air-to-fuel ratio (calculated with A/F_{st} and λ_i according to paragraph 7.3.) as follows:

$$q_{mew,i} = q_{maw,i} \times \left(1 + \frac{1}{A/F_{st} \times l_i}\right)$$

$$q_{mew,i} = q_{mf,i} \times \left(1 + A/F_{st} \times l_i\right)$$

The calculated instantaneous exhaust mass flow rate shall meet the linearity requirements specified for the exhaust gas mass flow rate in paragraph 3. of Appendix 5 and the validation requirements specified in paragraph 4.3. of Appendix 6.

8. CALCULATING THE INSTANTANEOUS MASS EMISSIONS OF GASEOUS COMPONENTS

The instantaneous mass emissions [g/s] shall be determined by multiplying the instantaneous concentration of the pollutant under consideration [ppm] with the instantaneous exhaust mass flow rate [kg/s], both corrected and aligned for the transformation time, and the respective *u* value in Table A7/1. If measured on a dry basis, the dry-wet correction according to paragraph 5.1. shall be applied to the instantaneous component concentrations before executing any further calculations. If occurring, negative instantaneous emission values shall enter all subsequent data evaluations. Parameter values shall enter the calculation of instantaneous emissions [g/s] as reported by the analyser, flow-measuring instrument, sensor or the ECU. The following equation shall be applied:

$$m_{\mathrm{gas,i}} = u_{\mathrm{gas}} \cdot C_{\mathrm{gas,i}} \cdot q_{\mathrm{mew,i}}$$

where:

$m_{\mathrm{gas,i}}$		is the mass of the exhaust component 'gas' [g/s]
u_{gas}		is the ratio of the density of the exhaust component 'gas' and the overall density of the exhaust as listed in Table A7/1
$c_{\mathrm{gas,i}}$		is the measured concentration of the exhaust component 'gas' in the exhaust [ppm]
$q_{\mathrm{mew,i}}$		is the measured exhaust mass flow rate [kg/s]
gas		is the respective component
i		number of the measurement

Table A7/1

Raw exhaust gas u values depicting the ratio between the densities of exhaust component or pollutant i [kg/m³] and the density of the exhaust gas [kg/m³]

Fuel	ρ_e [kg/m³]	Component or pollutant i					
		NO_x	CO	HC	CO_2	O_2	CH_4
		ρ_{gas} [kg/m³]					
		2,052	1,249	(1)	1,9630	1,4276	0,715
		u_{gas} (2), (6)					
Diesel (B0)	1,2893	0,001593	0,000969	0,000480	0,001523	0,001108	0,000555
Diesel (B5)	1,2893	0,001593	0,000969	0,000480	0,001523	0,001108	0,000555
Diesel (B7)	1,2894	0,001593	0,000969	0,000480	0,001523	0,001108	0,000555
Ethanol (ED95)	1,2768	0,001609	0,000980	0,000780	0,001539	0,001119	0,000561
CNG (3)	1,2661	0,001621	0,000987	0,000528 (4)	0,001551	0,001128	0,000565
Propane	1,2805	0,001603	0,000976	0,000512	0,001533	0,001115	0,000559
Butane	1,2832	0,001600	0,000974	0,000505	0,001530	0,001113	0,000558
LPG (5)	1,2811	0,001602	0,000976	0,000510	0,001533	0,001115	0,000559
Petrol (E0)	1,2910	0,001591	0,000968	0,000480	0,001521	0,001106	0,000554
Petrol (E5)	1,2897	0,001592	0,000969	0,000480	0,001523	0,001108	0,000555
Petrol (E10)	1,2883	0,001594	0,000970	0,000481	0,001524	0,001109	0,000555
Ethanol (E85)	1,2797	0,001604	0,000977	0,000730	0,001534	0,001116	0,000559

(1) depending on fuel
(2) at λ = 2, dry air, 273 K, 101,3 kPa
(3) *u* values accurate within 0,2 % for mass composition of: C=66-76 %; H=22-25 %; N=0-12 %
(4) NMHC on the basis of $CH_{2,93}$ (for THC the u_{gas} coefficient of CH_4 shall be used)
(5) *u* accurate within 0,2 % for mass composition of: C_3=70-90 %; C_4=10-30 %
(6) u_{gas} is a unitless parameter; the u_{gas} values include unit conversions to ensure that the instantaneous emissions are obtained in the specified physical unit, i.e., g/s

9. CALCULATING THE INSTANTANEOUS PARTICLE NUMBER EMISSIONS

The instantaneous particle number emissions [particles/s] shall be determined by multiplying the instantaneous concentration of the pollutant under consideration [particles/cm³] with the instantaneous exhaust mass flow rate [kg/s], both corrected and aligned for the transformation time and by dividing with the density [kg/m³] according to Table A7/1. If applicable, negative instantaneous emission values shall enter all subsequent data evaluations. All significant digits of preceding results shall enter the calculation of the instantaneous emissions. The following equation shall apply:

$$PN_i = C_{PN,i} q_{mew,i} / \rho_e$$

where:

PNi		is the particle number flux [particles/s]
$c_{PN,i}$		is the measured particle number concentration [#/m^3] normalized at 0 °C
$q_{mew,i}$		is the measured exhaust mass flow rate [kg/s]
ρ_e		is the density of the exhaust gas [kg/m^3] at 0 °C (Table A7/1)

10. DATA EXCHANGE

Data Exchange: The data shall be exchanged between the measurement systems and the data evaluation software by a standardised data exchange file provided by the Commission[6].

Any pre-processing of data (e.g. time correction according to paragraph 3, vehicle speed correction according to paragraph 4.7 of Appendix 4 or the correction of the GNSS vehicle speed signal according to paragraph 6.5. of Appendix 4) shall be done with the control software of the measurement systems and shall be completed before the data exchange file is generated.

Appendix 8

Assessment of overall trip validity using the moving averaging window method

1. INTRODUCTION

The Moving Averaging Window method shall be used to assess the overall trip dynamics. The test is divided in sub-sections (windows) and the subsequent analysis aims at determining whether the trip is valid for RDE purposes. The 'normality' of the windows shall be assessed by comparing their CO_2 distance-specific emissions with a reference curve obtained from the vehicle CO_2 emissions measured in accordance with the WLTP test.

2. SYMBOLS, PARAMETERS AND UNITS

Index (i) refers to the time step

Index (j) refers to the window

Index (k) refers to the category (t=total, ls=low speed, ms=medium speed, hs=high speed) or to the CO_2 characteristic curve (cc)

a_1,b_1 - coefficients of the CO_2 characteristic curve

a_2,b_2 - coefficients of the CO_2 characteristic curve

M_{CO2} - CO_2 mass, [g]

M_{CO2j} - CO_2 mass in window j, [g]

t_i - total time in step i, [s]

t_t - duration of a test, [s]

v_i - actual vehicle speed in time step i, [km/h]

$\bar{v}_j$ - average vehicle speed in window j, [km/h]

tol_{1H} - upper tolerance for the vehicle CO_2 characteristic curve, [%]

tol_{1L} - lower tolerance for the vehicle CO_2 characteristic curve, [%]

3. MOVING AVERAGING WINDOWS

3.1. **Definition of averaging windows**

The instantaneous CO_2 emissions calculated according to Appendix 7 shall be integrated using a moving averaging window method, based on a reference CO_2 mass.

The usage of the reference CO_2 mass is illustrated in Figure A8/2. The principle of the calculation is as follows: The RDE distance-specific CO_2 mass emissions are not calculated for the complete data set, but for sub-sets of the complete data set, the length of these sub-sets being determined so as to match always the same fraction of the CO_2 mass emitted by the vehicle over the applicable WLTP test (after all appropriate corrections e.g. ATCT are applied, where relevant). The moving window calculations are conducted with a time increment Δt corresponding to the data sampling frequency. These sub-sets used to calculate the vehicle on-road CO_2 emissions and its average speed are referred to as 'averaging windows' in the following sections. The calculation described in this point shall be run from the first data point (forward), as shown in Figure A8/1.

The following data shall not be considered for the calculation of the CO_2 mass, the distance and the vehicle average speed in each averaging window:

The periodic verification of the instruments and/or after the zero drift verifications;

Vehicle ground speed < 1 km/h;

The calculation shall start from when vehicle ground speed is higher than or equal to 1 km/h and include driving events during which no CO_2 is emitted and where the vehicle ground speed is higher than or equal to 1 km/h.

The mass emissions $M_{CO_2,j}$ shall be determined by integrating the instantaneous emissions in g/s as specified in Appendix 7.

Figure A8/1

Vehicle speed versus time - Vehicle averaged emissions versus time, starting from the first averaging window

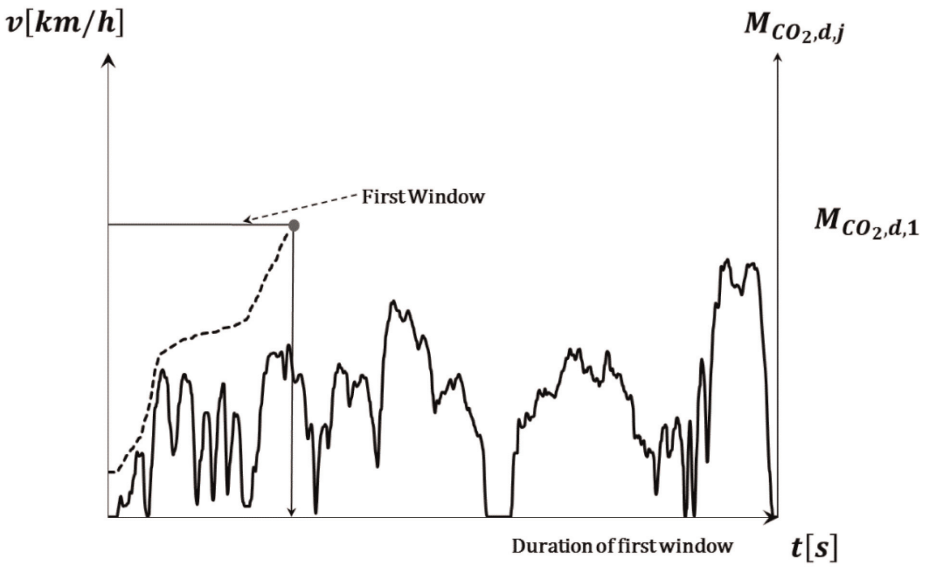
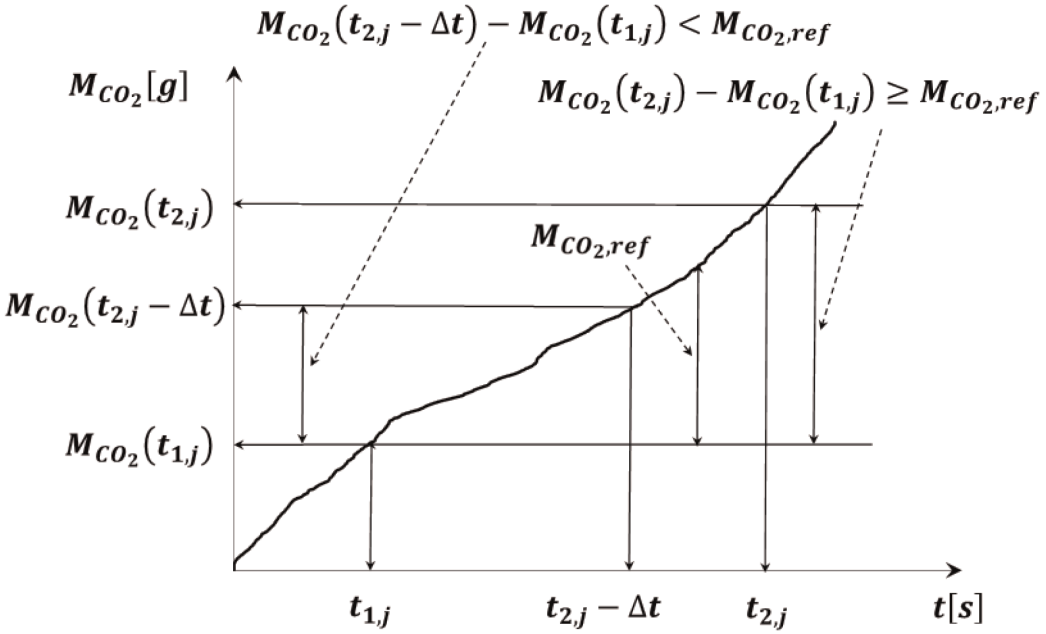


Figure A8/2

Definition of CO_2 mass based on averaging windows



The duration $(t_{2,j} - t_{1,j})$ of the j^{th} averaging window is determined by:

$$M_{CO2}\ (t_{2,j}) - M_{CO2}\ (t_{1,j}) \geq M_{CO2,ref}$$

Where:

$M_{CO2}(t_{i,j})$ is the CO_2 mass measured between the test start and time $t_{i,j}$, [g];

$M_{CO2,ref}$ is the reference CO_2 mass (half of the CO_2 mass emitted by the vehicle over the applicable WLTP test).

During type approval, the CO_2 reference value shall be taken from the WLTP test CO_2 values of the individual vehicle, obtained in accordance with UN Regulation 154, including all appropriate corrections.

For ISC or market surveillance testing purposes, the reference CO_2 mass shall be obtained from the Certificate of Conformity ([28]) for the individual vehicle. The value for OVC-HEV vehicles shall be obtained from the WLTP test conducted using the Charge Sustaining mode.

$t_{2,j}$ shall be selected such as:

$$M_{CO2}\ (t_{2,j} - \Delta t) - M_{CO2}\ (t_{1,j}) < M_{CO2,ref} \leq M_{CO2}\ (t_{2,j}) - M_{CO2}\ (t_{1,j})$$

Where Δt is the data sampling period.

The CO_2 masses $M_{CO_2,j}$ in the windows are calculated by integrating the instantaneous emissions calculated as specified in Appendix 7.

([28]) As found in Annex VIII of Regulation (EU) 2020/638.

3.2. **Calculation of window parameters**

— The following shall be calculated for each window determined in accordance with paragraph 3.1. The distance-specific CO_2 emissions $M_{CO_2,d,j}$;

— The average vehicle speed $\overline{v}_j$

4. EVALUATION OF WINDOWS

4.1. **Introduction**

The reference dynamic conditions of the test vehicle are defined from the vehicle CO_2 emissions versus average speed measured at type approval on the WLTP test and referred to as 'vehicle CO_2 characteristic curve'.

4.2. **CO_2 characteristic curve reference points**

During type approval, the values shall be taken from the WLTP CO_2 values of the individual vehicle, obtained in accordance with UN Regulation 154, including all appropriate corrections.

For ISC or market surveillance testing purposes, the distance-specific CO_2 emissions to be considered, in this paragraph for the definition of the reference curve shall be obtained from the Certificate of Conformity for the individual vehicle.

The reference points P_1, P_2 and P_3 required to define the vehicle CO_2 characteristic curve shall be established as follows:

4.2.1. *Point P_1*

$\overline{v_{P1}} = 18{,}882 km/h$ (Average Speed of the Low Speed phase of the WLTP cycle)

M_{CO_2,d,P_1} = Vehicle CO_2 emissions over the Low Speed phase of the WLTP test [g/km]

4.2.2. *Point P_2*

$\overline{v_{P2}} = 56{,}664 km/h$ (Average Speed of the High Speed phase of the WLTP cycle)

M_{CO_2,d,P_2} = Vehicle CO_2 emissions over the High Speed phase of the WLTP test [g/km]

4.2.3. *Point P_3*

$\overline{v_{P3}} = 91{,}997 km/h$(Average Speed of the Extra High Speed phase of the WLTP cycle)

M_{CO_2,d,P_3}= Vehicle CO_2 emissions over the Extra High Speed phase of the WLTP test [g/km]

4.3. **CO_2 characteristic curve definition**

Using the reference points defined in paragraph 4.2., the characteristic curve CO_2 emissions are calculated as a function of the average speed using two linear sections (P_1, P_2) and (P_2, P_3). The section (P_2, P_3) is limited to 145 km/h on the vehicle speed axis. The characteristic curve is defined by equations as follows:

For the section (P_1,P_2):

$$M_{CO_2,d,CC}(\overline{v}) = a_1\overline{v} + b_1$$

with: $a_1 = (M_{CO_2,d,P_2} - M_{CO_2,d,P_1})/(\overline{v_{P_2}} - \overline{v_{P_1}})$

and: $b_1 = M_{CO_2,d,P_1} - a_1\overline{v_{P_1}}$

For the section (P_2,P_3):

$$M_{CO_2,d,CC}(\overline{v}) = a_2\overline{v} + b_2$$

with: $a_2 = (M_{CO_2,d,P_3} - M_{CO_2,d,P_2})/(\overline{v_{P_3}} - \overline{v_{P_2}})$

and: $b_2 = M_{CO_2,d,P_2} - a_2\overline{v_{P_2}}$

Figure A8/3

Vehicle CO_2 characteristic curve and tolerances for ICE and NOVC-HEV vehicles

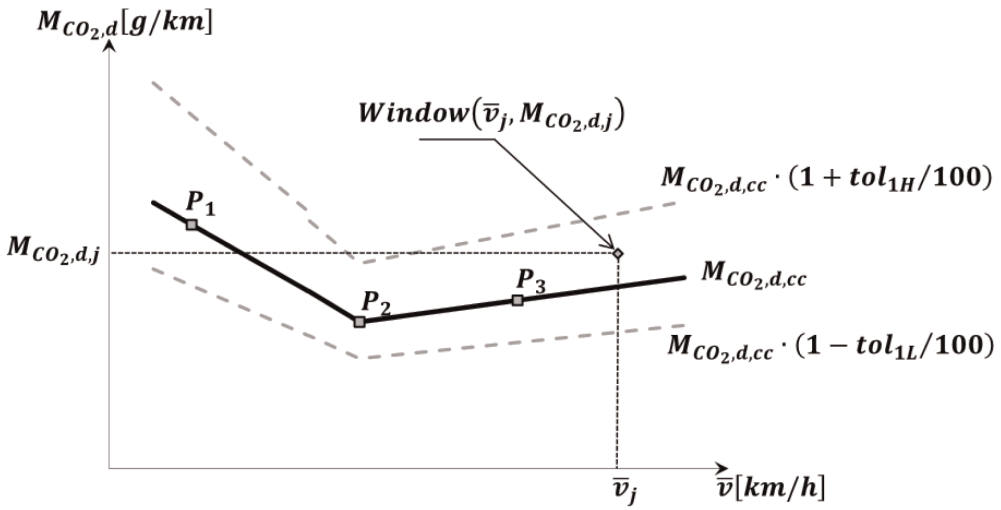
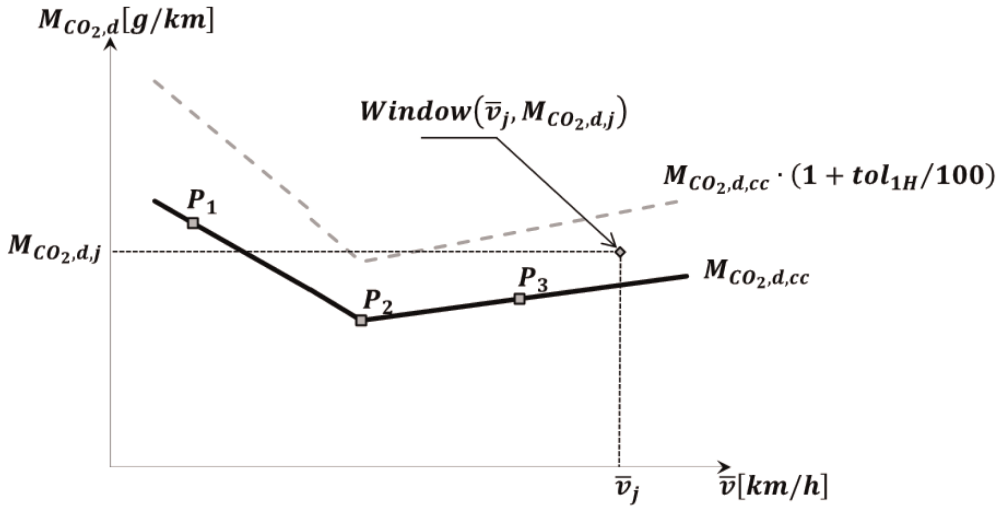


Figure A8/4

Vehicle CO_2 characteristic curve and tolerances for OVC-HEV vehicles



4.4. **Low, medium and high-speed windows**

4.4.1. The windows shall be categorised into low, medium, and high speed bins according to their average speed.

4.4.1.1. Low-speed windows

Low-speed windows are characterized by average vehicle ground speeds $\overline{v}_j$ lower than 45 km/h.

4.4.1.2. Medium-speed windows

Medium-speed windows are characterized by average vehicle ground speeds $\overline{v}_j$ greater than or equal to 45 km/h and lower than 80 km/h.

For those vehicles that are equipped with a device limiting vehicle speed to 90 km/h, medium-speed windows are characterized by average vehicle speeds $\overline{v}_j$ lower than 70 km/h.

4.4.1.3. High-speed windows

High-speed windows are characterized by average vehicle ground speeds $\overline{v}_j$ greater than or equal to 80 km/h and lower than 145 km/h

For those vehicles that are equipped with a device limiting vehicle speed to 90 km/h, high-speed windows are characterized by average vehicle speeds $\overline{v}_j$ greater than or equal to 70 km/h and lower than 90 km/h.

Figure A8/5

Vehicle CO_2 characteristic curve: low, medium and high speed definitions (Illustrated for ICE and NOVC-HEV vehicles) except N2 category vehicles that are equipped with a device limiting vehicle speed to 90 km/h

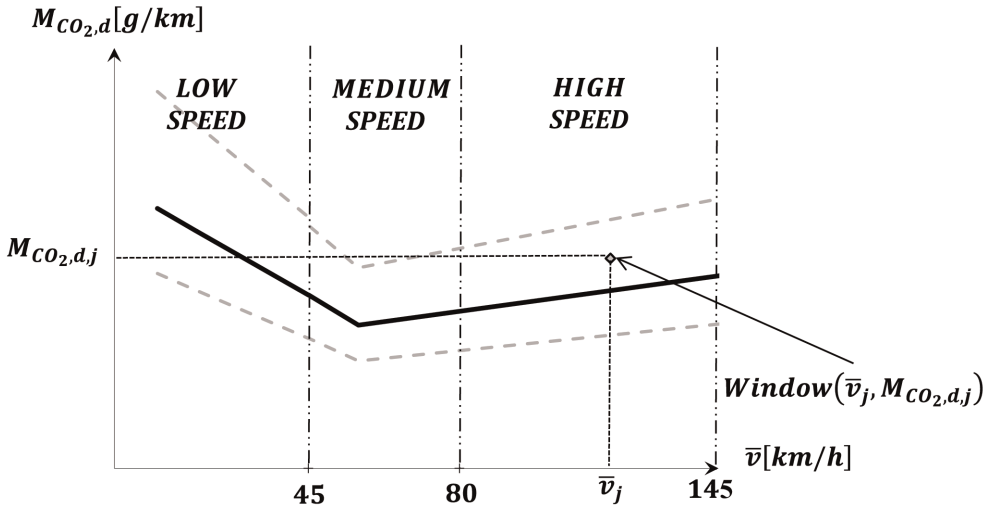
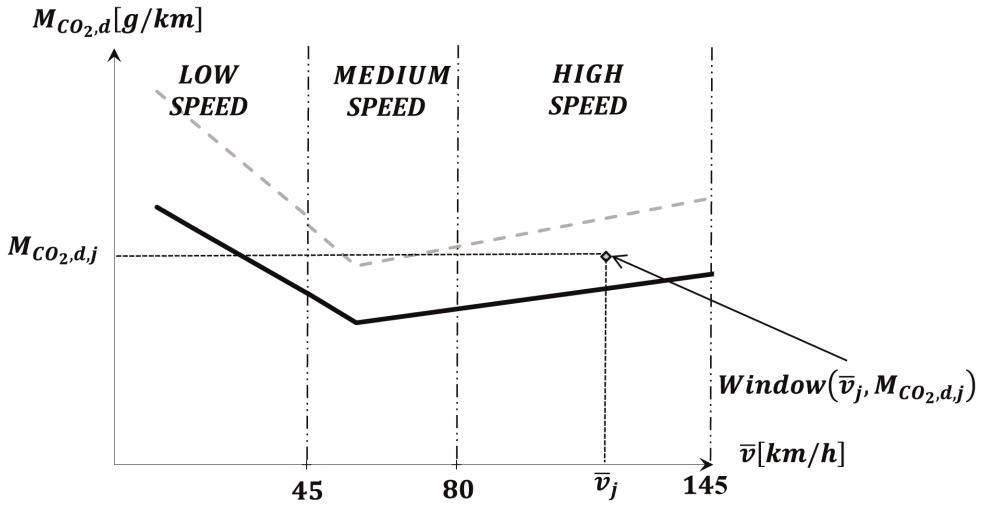


Figure A8/6

Vehicle CO_2 characteristic curve: low, medium and high speed driving definitions (Illustrated for OVC-HEV vehicles) except those vehicles that are equipped with a device limiting vehicle speed to 90 km/h



4.5.1. Assessment of trip validity

4.5.1.1. Tolerances around the vehicle CO_2 characteristic curve

The upper tolerance of the vehicle CO_2 characteristic curve is tol_{1H} = 45 % for low speed driving and tol_{1H} = 40 % for medium and high speed driving.

The lower tolerance of the vehicle CO_2 characteristic curve is tol_{1L} = 25 % for ICE and NOVC-HEV vehicles and tol_{1L} = 100 % for OVC-HEV vehicles.

4.5.1.2. Assessment of test validity

The test is valid when it comprises at least 50 per cent of the low, medium and high speed windows that are within the tolerances defined for the CO_2 characteristic curve.

For NOVC-HEVs and OVC-HEVs, if the minimum requirement of 50 % between tol_{1H} and tol_{1L} is not met, the upper positive tolerance tol_{1H} may be increased until the value of tol_{1H} reaches 50 per cent.

For OVC-HEVs when no MAWs are calculated as result of the ICE not turning on, the test is still valid.

Appendix 9

Assessment of excess or absence of trip dynamics

1. INTRODUCTION

This appendix describes the calculation procedures to verify the trip dynamics by determining the excess or absence of dynamics during an RDE trip.

2. SYMBOLS, PARAMETERS AND UNITS

a	—	acceleration [m/s^2]
a_i	—	Acceleration in time step i [m/s^2]
a_{pos}	—	positive acceleration greater than 0,1 m/s^2 [m/s^2]
$a_{pos,i,k}$	—	positive acceleration greater than 0,1 m/s^2 in time step i considering the urban, rural and motorway shares [m/s^2]
a_{res}	—	acceleration resolution [m/s^2]
d_i	—	distance covered in time step i [m]
$d_{i,k}$	—	distance covered in time step i considering the urban, rural and motorway shares [m]
Index (i)	—	discrete time step
Index (j)	—	discrete time step of positive acceleration datasets
Index (k)	—	refers to the respective category (t=total, u=urban, r=rural, m=motorway)
M_k	—	number of samples for urban, rural and motorway shares with positive acceleration greater than 0,1 m/s^2
N_k	—	total number of samples for the urban, rural and motorway shares and the complete trip
RPA_k	—	relative positive acceleration for urban, rural and motorway shares [m/s^2 or kWs/(kg*km)]
t_k	—	duration of the urban, rural and motorway shares and the complete trip [s]
v	—	vehicle speed [km/h]
v_i	—	actual vehicle speed in time step i [km/h]
$v_{i,k}$	—	actual vehicle speed in time step i considering the urban, rural and motorway shares [km/h]
$(v \times a)_i$	—	actual vehicle speed per acceleration in time step i [m^2/s^3 or W/kg]

$(v \times a)_{j,k}$	—	actual vehicle speed per positive acceleration greater than 0,1 m/s^2 in time step j considering the urban, rural and motorway shares [m^2/s^3 or W/kg].
$(v \times a_{pos})_{k}$-[95]	—	95th percentile of the product of vehicle speed per positive acceleration greater than 0,1 m/s^2 for urban, rural and motorway shares [m^2/s^3 or W/kg]
$\overline{v}_k$	—	average vehicle speed for urban, rural and motorway shares [km/h]

3. TRIP INDICATORS

3.1. **Calculations**

3.1.1. *Data pre-processing*

Dynamic parameters, such as acceleration, ($v \times a_{apos}$) or RPA, shall be determined with a speed signal of an accuracy of 0,1 % for all speed values above 3 km/h and a sampling frequency of 1 Hz. Otherwise, acceleration shall be determined with an accuracy of 0,01 m/s^2 and a sampling frequency of 1 Hz. In this case, a separate speed signal is required for ($v \times a_{apos}$) and shall have an accuracy of at least 0,1 km/h. The speed trace shall form the basis for further calculations and binning as described in paragraphs 3.1.2. and 3.1.3.

3.1.2. *Calculation of distance, acceleration and ($v \times a$)*

The following calculations shall be performed over the whole time based speed trace from the beginning to the end of the test data.

The distance increment per data sample shall be calculated as follows:

$$d_i = \frac{v_i}{3,6} \; i = 1 \; to \; N_t$$

where:

d_i		is the distance covered in time step i [m]
v_i		is the actual vehicle speed in time step i [km/h]
N_t		is the total number of samples

The acceleration shall be calculated as follows:

$$a_i = \frac{v_{i+1} - v_{i-1}}{2 \times 3,6} \; i = 1 \; to \; N_t$$

where:

a*i*		is the acceleration in time step i [m/s^2]. For i = 1: v_{i-1} = 0, for i = N_t: v_{i+1} =0.

The product of vehicle speed per acceleration shall be calculated as follows:

$$(v \times a)_i = \frac{v_i \times a_i}{3,-6}$$

where:

$(v \times a)_i$		is the product of the actual vehicle speed per acceleration in time step i [m^2/s^3 or W/kg].

3.1.3. *Binning of the results*

3.1.3.1. Binning of the results

After the calculation of a_i and $(v \times a)_i$, the values v_i, d_i, a_i and $(v \times a)_i$ shall be ranked in ascending order of the vehicle speed.

All datasets with ($v_i \leq 60$ km/h) belong to the 'urban' speed bin, all datasets with (60 km/h < $v_i \leq 90$ km/h) belong to the 'rural' speed bin and all datasets with ($v_i > 90$ km/h) belong to the 'motorway' speed bin.

For N2 category vehicles that are equipped with a device limiting vehicle speed to 90 km/h, all datasets with $v_i \leq 60$ km/h belong to the "urban" speed bin, all datasets with 60 km/h < $v_i \leq 80$ km/h belong to the "rural" speed bin and all datasets with $v_i > 80$ km/h belong to the "motorway" speed bin.

The number of datasets with acceleration values a_i 0,1 m/s^2 shall be greater than or equal to 100 in each speed bin.

For each speed bin the average vehicle speed ($\overline{v}_k$) shall be calculated as follows:

$$\overline{v}_k = \frac{1}{N_k} \sum_i v_{i,k} \; i = 1 \; to \; N_k, k = u, r, m$$

where:

N_k		is the total number of samples of the urban, rural, and motorway shares.

3.1.4. Calculation of $(v \times a_{pos})_k$-[95] per speed bin

The 95th percentile of the $(v \times a_{pos})$ values shall be calculated as follows:

The $(v \times a_{pos})_{i,k}$ values in each speed bin shall be ranked in ascending order for all datasets with $a_{i,k} > 0{,}1 m/s^2$ and the total number of these samples M_k shall be determined.

Percentile values are then assigned to the $(v \times a_{pos})_{i,k}$ values with $a_{i,k} > 0{,}1$ m/s^2 as follows:

The lowest $(v \times a_{pos})$value gets the percentile $1/M_k$, the second lowest $2/M_k$, the third lowest $3/M_k$ and the highest value (M_k/M_k = 100 %.)

$(v \times a_{pos})_k$-[95] is the $(v \times a_{pos})_{j,k}$ value, with j/M_k = 95 %. If j/M_k = 95 % cannot be met, $(v \times a_{pos})_k$-[95] shall be calculated by linear interpolation between consecutive samples *j* and *j+1* with j/M_k < 95 % and $(j+1)/M_k$ > 95 %.

The relative positive acceleration per speed bin shall be calculated as follows:

$$RPA_k = \frac{\sum_j (v \times a_{pos}) j,k}{\sum_i d_{i,k}}, j = 1 \text{ to } M_k, i = 1 \text{ to } N_k,\ k = u,\ r,\ m$$

where:

RPA_k		is the relative positive acceleration for urban, rural and motorway shares in [m/s^2 or kWs/(kg*km)]
M_k		is the sample number for urban, rural and motorway shares with positive acceleration
N_k		is the total sample number for urban, rural and motorway shares

4. ASSESSMENT OF TRIP VALIDITY

4.1.1. Assessment of $(v \times a_{pos})_k$-[95] per speed bin (with v in [km/h])

If $\bar{v}_k \leq 74{,}6$ *km/h* and

$(v \times a_{pos})_k$-[95] > $(0{,}136 \times \bar{v}_k + 14{,}44)$

is fulfilled, the trip is invalid.

If $\bar{v}_k > 74{,}6$ *km/h* and

$(v \times a_{pos})_k$-[95] > $(0{,}0742 \times \bar{v}_k + 18{,}966)$

is fulfilled, the trip is invalid.

Upon the request of the manufacturer, and only for those N1 or N2 vehicles where the vehicle power-to-test mass ratio is less than or equal to 44 W/kg then:

If $\bar{v}_k \leq 74{,}6$ *km/h* and

$(v \times a_{pos})_k$-[95] > $(0{,}136 \times \bar{v}_k + 14{,}44)$

is fulfilled, the trip is invalid.

If $\bar{v}_k > 74{,}6$ *km/h* and

$(v \times a_{pos})_k$-[95] > $(-\ 0{,}097 \times \bar{v}_k + 31{,}365)$

is fulfilled, the trip is invalid.

4.1.2. Assessment of RPA per speed bin

If $\bar{v}_k \leq 94{,}05$ *km/h* and

$RPA_k < (-\ 0{,}0016\ \bar{v}_k + 0{,}1755)$

is fulfilled, the trip is invalid.

If $\bar{v}_k > 94{,}05$ *km/h* and $RPA_k < 0{,}025$ is fulfilled, the trip is invalid.

Appendix 10

Procedure to determine the cumulative positive elevation gain of a PEMS trip

1. INTRODUCTION

This appendix describes the procedure to determine the cumulative elevation gain of a PEMS trip.

2. SYMBOLS, PARAMETERS AND UNITS

$d(0)$	—	distance at the start of a trip [m]
d	—	cumulative distance travelled at the discrete way point under consideration [m]
d_0	—	cumulative distance travelled until the measurement directly before the respective way point d [m]
d_1	—	cumulative distance travelled until the measurement directly after the respective way point d [m]
d_a	—	reference way point at $d(0)$ [m]
d_e	—	cumulative distance travelled until the last discrete way point [m]
d_i	—	instantaneous distance [m]
d_{tot}	—	total test distance [m]
$h(0)$	—	vehicle altitude after the screening and principle verification of data quality at the start of a trip [m above sea level]
$h(t)$	—	vehicle altitude after the screening and principle verification of data quality at point t [m above sea level]
$h(d)$	—	vehicle altitude at the way point d [m above sea level]
$h(t-1)$	—	vehicle altitude after the screening and principle verification of data quality at point t-1 [m above sea level]
$h_{corr}(0)$	—	corrected altitude directly before the respective way point d [m above sea level]
$h_{corr}(1)$	—	corrected altitude directly after the respective way point d [m above sea level]
$h_{corr}(t)$	—	corrected instantaneous vehicle altitude at data point t [m above sea level]
$h_{corr}(t-1)$	—	corrected instantaneous vehicle altitude at data point t-1 [m above sea level]
$h_{GNSS,i}$	—	instantaneous vehicle altitude measured with GNSS [m above sea level]
$h_{GNSS}(t)$	—	vehicle altitude measured with GNSS at data point t [m above sea level]
$h_{int}(d)$	—	interpolated altitude at the discrete way point under consideration d [m above sea level]

$h_{int,sm,1}(d)$	—	smoothed and interpolated altitude, after the first smoothing run at the discrete way point under consideration d [m above sea level]
$h_{map}(t)$	—	vehicle altitude based on topographic map at data point t [m above sea level]
$road_{grade,1}(d)$	—	smoothed road grade at the discrete way point under consideration d after the first smoothing run [m/m]
$road_{grade,2}(d)$	—	smoothed road grade at the discrete way point under consideration d after the second smoothing run [m/m]
sin	—	trigonometric sine function
t	—	time passed since test start [s]
t_0	—	time passed at the measurement directly located before the respective way point d [s]
v_i	—	instantaneous vehicle speed [km/h]
$v(t)$	—	vehicle speed at a data point t [km/h]

3. GENERAL REQUIREMENTS

The cumulative positive elevation gain of a RDE trip shall be determined based on three parameters: the instantaneous vehicle altitude $h_{GNSS,i}$ [m above sea level] as measured with the GNSS, the instantaneous vehicle speed v_i [km/h] recorded at a frequency of 1 Hz and the corresponding time t [s] that has passed since test start.

4. CALCULATION OF CUMULATIVE POSITIVE ELEVATION GAIN

4.1. **General**

The cumulative positive elevation gain of a RDE trip shall be calculated as a two-step procedure, consisting of (i) the correction of instantaneous vehicle altitude data, and (ii) the calculation of the cumulative positive elevation gain.

4.2. **Correction of instantaneous vehicle altitude data**

The altitude $h(0)$ at the start of a trip at $d(0)$ shall be obtained by GNSS and verified for correctness with information from a topographic map. The deviation shall not be larger than 40 m. Any instantaneous altitude data $h(t)$ shall be corrected if the following condition applies:

$$|h(t) - h(t-1)| > v(t)/3.6 \times sin45°$$

The altitude correction shall be applied so that:

$$h_{corr}(t) = h_{corr}(t-1)$$

where:

h(t)	—	vehicle altitude after the screening and principle check of data quality at data point t [m above sea level]
h(t-1)	—	vehicle altitude after the screening and principle check of data quality at data point t-1 [m above sea level]

v(t)	—	vehicle speed of data point t [km/h]
$h_{corr}(t)$	—	corrected instantaneous vehicle altitude at data point t [m above sea level]
$h_{corr}(t-1)$	—	corrected instantaneous vehicle altitude at data point t-1 [m above sea level]

Upon the completion of the correction procedure, a valid set of altitude data is established. This data set shall be used for the calculation of the cumulative positive elevation gain as described in the following.

4.3. **Final calculation of the cumulative positive elevation gain**

4.3.1. *Establishment of a uniform spatial resolution*

The cumulative elevation gain shall be calculated from data of a constant spatial resolution of 1 m starting with the first measurement at the start of a trip *d(0)*. The discrete data points at a resolution of 1 m are referred to as way points, characterized by a specific distance value d (e.g., 0, 1, 2, 3 m…) and their corresponding altitude *h(d)* [m above sea level].

The altitude of each discrete way point *d* shall be calculated through interpolation of the instantaneous altitude $h_{corr}(t)$ as:

$$h_{int}(d) = h_{corr}(0) + \frac{h_{corr}(1) - h_{corr}(0)}{d_1 - d_0} \times (d - d_0)$$

Where:

$h_{int}(d)$	—	interpolated altitude at the discrete way point under consideration *d* [m above sea level]
$h_{corr}(0)$	—	corrected altitude directly before the respective way point *d* [m above sea level]
$h_{corr}(1)$	—	corrected altitude directly after the respective way point *d* [m above sea level]
d	—	cumulative distance travelled at the discrete way point under consideration *d* [m]
d_0	—	cumulative distance travelled until the measurement located directly before the respective way point *d* [m]
d_1	—	cumulative distance travelled until the measurement located directly after the respective way point *d* [m]

4.3.2. *Additional data smoothing*

The altitude data obtained for each discrete way point shall be smoothed by applying a two-step procedure; d_a and d_e denote the first and last data point respectively (Figure A10/1). The first smoothing run shall be applied as follows:

$$road_{grade,1}(d) = \frac{h_{int}(d + 200\ m) - h_{int}(d_a)}{(d + 200\ m)} for\ d \leq 200\ m$$

$$road_{grade,1}(d) = \frac{h_{int}(d + 200\ m) - h_{int}(d - 200\ m)}{(d + 200\ m) - (d - 200\ m)} for 200\ m < d < (d_e - 200\ m)$$

$$road_{grade,1}(d) = \frac{h_{int}(d_e) - h_{int}(d - 200\ m)}{d_e - (d - 200\ m)} for\ d \geq (d_e - 200\ m)$$

$$h_{int,sm,1}(d) = h_{int,sm,1}(d - 1\ m) + road_{grade,1}(d)\ for d = (d_a + 1)\ to\ d_e$$

$$h_{int,sm,1}(d_a) = h_{int}(d_a) + road_{grade,1}(d_a)$$

Where:

$road_{grade,1}(d)$	—	smoothed road grade at the discrete way point under consideration after the first smoothing run [m/m]
$h_{int}(d)$	—	interpolated altitude at the discrete way point under consideration d [m above sea level]
$h_{int,sm,1}(d)$	—	smoothed interpolated altitude, after the first smoothing run at the discrete way point under consideration d [m above sea level]
d	—	cumulative distance travelled at the discrete way point under consideration [m]
d_a	—	reference way point at $d(0)$ [m]
d_e	—	cumulative distance travelled until the last discrete way point [m]

The second smoothing run shall be applied as follows:

$$road_{grade,2}(d) = \frac{h_{int,sm,1}(d + 200\ m) - h_{int,sm,1}(d_a)}{(d + 200\ m)} for\ d \leq 200\ m$$

$$road_{grade,2}(d) = \frac{h_{int,sm,1}(d + 200\ m) - h_{int,sm,1}(d - 200\ m)}{(d + 200\ m) - (d - 200\ m)} for 200\ m < d < (d_e - 200\ m)$$

$$road_{grade,2}(d) = \frac{h_{int,sm,1}(d_e) - h_{int,sm,1}(d - 200\ m)}{d_e - (d - 200\ m)} for\ d \geq (d_e - 200\ m)$$

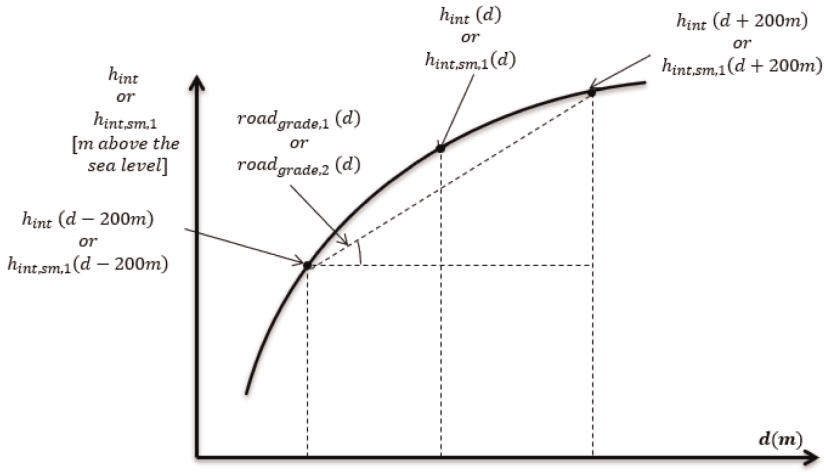
Where:

$road_{grade,2}(d)$	—	smoothed road grade at the discrete way point under consideration after the second smoothing run [m/m]
$h_{int,sm,1}(d)$	—	smoothed interpolated altitude, after the first smoothing run at the discrete way point under consideration d [m above sea level]
d	—	cumulative distance travelled at the discrete way point under consideration [m]

d_a	—	reference way point at *d(0)* [m]
d_e	—	cumulative distance travelled until the last discrete way point [m]

Figure A10/1

Illustration of the procedure to smooth the interpolated altitude signals



4.3.3. *Calculation of the final result*

The positive cumulative elevation gain of a total trip shall be calculated by integrating all positive interpolated and smoothed road grades, i.e., $road_{grade,2}(d)$. The result should be normalized by the total test distance d_{tot} and expressed in meters of cumulative elevation gain per one hundred kilometres of distance.

The waypoint vehicle speed v_w shall then be calculated over each discrete way point of 1m:

$$v_w = \frac{1}{(t_{w,i} - t_{w,i-1})}$$

The positive cumulative elevation gain of the urban part of a trip shall then be calculated based on the vehicle speed over each discrete way point. All datasets with $v_w \leq 60$ km/h belong to the urban part of the trip. All of the positive interpolated and smoothed road grades that correspond to urban datasets shall be integrated.

The number of 1m waypoints which correspond to urban datasets shall be integrated and converted to km to define the urban test distance d_{urban} [km].

The positive cumulative elevation gain of the urban part of the trip shall then be calculated by dividing the urban elevation gain by the urban test distance, and expressed in metres of cumulative elevation gain per one hundred kilometres of distance.

Appendix 11

Calculation of the final RDE emission results

1. This appendix describes the procedure to calculate the final pollutant emissions for the complete and urban part of an RDE trip

2. Symbols, Parameters and Units

Index (k) refers to the category (t=total, u=urban, 1-2=first two phases of the WLTP test)

IC_k	is the distance share of usage of the internal combustion engine for an OVC-HEV over the RDE trip
$d_{ICE,k}$	is the distance driven [km], with the internal combustion engine on for an OVC-HEV over the RDE trip
$d_{EV,k}$	is the distance driven [km], with the internal combustion engine off for an OVC-HEV over the RDE trip
$M_{RDE,k}$	is the final RDE distance-specific mass of gaseous pollutants [mg/km] or particle number [#/km]
$m_{RDE,k}$	is the distance-specific mass of gaseous pollutant [mg/km] or particle number [#/km] emissions, emitted over the complete RDE trip and prior to any correction in accordance with this appendix
$M_{CO_2,RDE,k}$	is the distance-specific mass of CO_2 [g/km], emitted over the RDE trip
$M_{CO_2,WLTC,k}$	is the distance-specific mass of CO_2 [g/km], emitted over the WLTC cycle
$M_{CO_2,WLTC_CS,k}$	is the distance-specific mass of CO_2 [g/km], emitted over the WLTC cycle for an OVC-HEV vehicle tested in charge sustaining vehicle operation
r_k	is the ratio between the CO_2 emissions measured during the RDE test and the WLTP test
RF_k	is the result evaluation factor calculated for the RDE trip
RF_{L1}	is the first parameter of the function used to calculate the result evaluation factor
RF_{L2}	is the second parameter of the function used to calculate the result evaluation factor

3. Calculation of the Intermediate RDE emissions results

For the valid trips, the intermediate RDE results are calculated as follows for vehicles with ICE, NOVC-HEV and OVC-HEV.

Any instantaneous emissions or exhaust flow measurements obtained while the combustion engine is deactivated, as defined in paragraph 2.5.2. of this Annex, shall be set to zero.

Any correction of the instantaneous pollutant emissions for Extended conditions according to paragraph 5.1., 7.5. and 7.6. of this Annex shall be applied.

For the complete RDE trip and for the urban part of the RDE trip (k=t=total, k=u=urban):

$$M_{RDE,k} = m_{RDE,k} \times RF_k$$

The values of the parameter RF_{L1} and RF_{L2} of the function used to calculate the result evaluation factor are as follows:

RF_{L1}=1.30 and RF_{L2}=1.50;

The RDE result evaluation factors RF_k (k=t=total, k=u=urban) shall be obtained using the functions laid down in paragraph 3.1. for vehicles with ICE and NOVC-HEV, and in paragraph 3.2. for OVC-HEV. A graphical illustration of the method is provided in Figure A11/1 below, while the mathematical formulas are found in Table A11/1:

Figure A11/1

Function to calculate the result evaluation factor

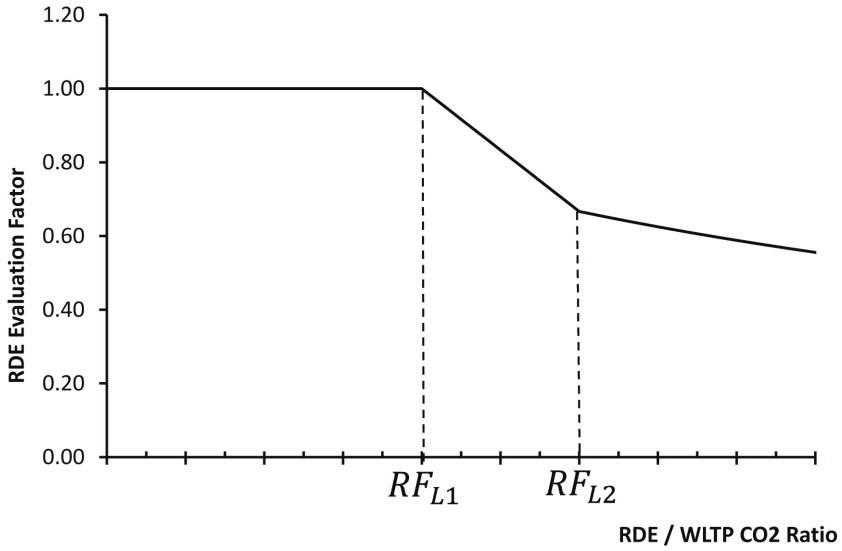


Table A11/1

Result evaluation factors calculation

When:	Then the Result evaluation factor RF_k is:	Where:
$r_k \leq RF_{L1}$	$RF_k = 1$	
$RF_{L1} < r_k \leq RF_{L2}$	$RF_k = a_1 r_k + b_1$	$a_1 = \frac{RF_{L2} - 1}{[RF_{L2} \times (RF_{L1} - RF_{L2})]}$ $b_1 = 1 - a_1 RF_{L1}$
$r_k > RF_{L2}$	$RF_k = \frac{1}{r_k}$	

3.1. RDE result evaluation factor for vehicles with ICE and NOVC-HEV

The value of the RDE result evaluation factor depends on the ratio r_k between the distance specific CO_2 emissions measured during the RDE test and the distance-specific CO_2 emitted by the vehicle over the validation WLTP test conducted on this vehicle including all appropriate corrections.

For the urban emissions, the relevant phases of the WLTP test shall be:

(a) for ICE vehicles, the first two WLTC phases, i.e. the Low and the Medium speed phases,

$$r_k = \frac{M_{CO_2,RDE,k}}{M_{CO_2,WLTP,k}}$$

(b) for NOVC-HEVs, all the phases of the WLTC driving cycle.

$$r_k = \frac{M_{CO_2,RDE,k}}{M_{CO_2,WLTP,t}}$$

3.2. RDE result evaluation factor for OVC-HEV

The value of the RDE result evaluation factor depends on the ratio r_k between the distance-specific CO_2 emissions measured during the RDE test and the distance-specific CO_2 emitted by the vehicle over the applicable WLTP test conducted in Charge Sustaining vehicle operation including all appropriate corrections. The ratio r_k is corrected by a ratio reflecting the respective usage of the internal combustion engine during the RDE trip and on the WLTP test, to be conducted in charge sustaining vehicle operation.

For either the urban or the total driving:

$$r_k = \frac{M_{CO_2,RDE,k}}{M_{CO_2,WLTP_CS,t}} \times \frac{0,85}{IC_k}$$

where IC_k is the ratio of the distance driven either in urban or total trip with the combustion engine activated, divided by the total urban or total trip distance:

$$IC_k = \frac{d_{ICE,k}}{d_{ICE,k} + d_{EV,k}}$$

With determination of combustion engine operation in accordance with paragraph 2.5.2. of this Annex.

4. Final RDE emission results taking into account the PEMS margin

In order to take into account the uncertainty of the PEMS measurements compared to the ones performed in the laboratory with the applicable WLTP test, the intermediate calculated emission values $M_{RDE,k}$ shall be divided by $1+margin_{pollutant.}$, where $margin_{pollutant}$ is defined in the Table A11/2:

The PEMS *margin* for each pollutant is specified as follows:

Table A11/2

Pollutant	Mass of oxides of nitrogen (NO_x)	Number of particles (PN)	Mass of carbon monoxide (CO)	Mass of total hydrocarbons (THC)	Combined mass of total hydrocarbons and oxides of nitrogen (THC + NO_x)
$Margin_{pollutant}$	0,10	0,34	*Not yet specified*	*Not yet specified*	*Not yet specified*

Any negative final results shall be set to zero.

Any Ki factors which are applicable, according to point 5.3.4. of this Annex, shall be applied.

These values shall be considered the Final RDE Emission Results for NO_x and PN.

Appendix 12

Manufacturer's RDE certificate of compliance

MANUFACTURER'S CERTIFICATE OF COMPLIANCE WITH THE REAL DRIVING EMISSIONS REQUIREMENTS

(Manufacturer): ....

(Address of the Manufacturer): ....

Certifies that:

The vehicle types listed in the attachment to this Certificate comply with the requirements laid down in point 3.1 of Annex IIIA to Regulation (EU) 2017/1151 for all valid RDE tests which are performed in accordance with the requirements of the above Annex.

Done at [..... (Place)]

On [(Date)]

[…] […]

.....

(Stamp and signature of the manufacturer's representative)

Annex:

— List of vehicle types to which this certificate applies

— List of the Declared Maximum RDE values for each vehicle type expressed as mg/km or particle numbers/km as appropriate.'.

ANNEX IV

In Annex V to Regulation (EU) 2017/1151, point 2.3 is replaced by the following:

'2.3. The road load coefficients to be used shall be those for vehicle low (VL). If VL does not exist, then the VH road load shall be used. In that case VH is defined in accordance with point 4.2.1.1.1 of Annex B4 to UN Regulation No 154. In case the interpolation method is used VL and VH are specified in point 4.2.1.1.2 of Annex B4 to UN Regulation No 154. Alternatively, the manufacturer may choose to use road loads that have been determined in accordance with the provisions of Appendix 7a or Appendix 7b to Annex 4a to UN/ECE Regulation No 83 for a vehicle included in the interpolation family.'

ANNEX V

Annex VI to Regulation (EU) 2017/1151 is amended as follows:

(1) point 2 is replaced by the following:

'2. GENERAL REQUIREMENTS

The general requirements for conducting the type 4 test shall be those set out in paragraph 6.6. of UN Regulation No 154. The limit value shall be that specified in Table 3 of Annex I to Regulation (EC) No 715/2007.';

(2) point 3. is replaced by the following:

'3. TECHNICAL REQUIREMENTS

The technical requirements for conducting the type 4 test shall be those set out in Annex C3 to UN Regulation No 154.';

(3) points 4, 5 and 6 are deleted;

(4) Appendix 1 is deleted.

ANNEX VI

Annex VII to Regulation (EU) 2017/1151 is amended as follows:

(1) point 1.1. is replaced by the following:

'1.1. This Annex describes the tests for verifying the durability of pollution control devices, as described in Annex C4 to UN Regulation No 154.';

(2) point 2.1. is replaced by the following:

'2.1. The general requirements for conducting the type 5 test shall be those set out in Section 6.7. of UN Regulation No 154.';

(3) points 2.2., 2.3. and 2.4. are deleted;

(4) point 3. is replaced by the following:

'3. The technical requirements for conducting the type 5 test shall be those set out in Annex C4 to UN Regulation No 154.'.

ANNEX VII

Annex VIII to Regulation (EU) 2017/1151 is amended a follows:

(1) Point 2.1 is replaced by the following:

'2.1. The general requirements for the Type 6 test are those set out in section 5.3.5 of UN/ECE Regulation No 83 with the exception specified in points 2.2 and 2.3 below.';

(2) Point 2.3 is added:

'2.3. Paragraph 5.3.5.1 of UN/ECE Regulation No 83 shall be replaced by "5.3.5.1. This test shall be carried out on all vehicles referred to in paragraph 1, except those having compression-ignition engines." ';

(3) Point 3.3. is replaced by the following:

'3.3. The road load coefficients to be used shall be those for vehicle low (VL). If VL does not exist then the vehicle high (VH) road load shall be used. In that case VH shall be specified in accordance with paragraph 4.2.1.1.1 of Annex B4 to UN Regulation No 154. In case the interpolation method is used VL and VH shall be specified in accordance with paragraph 4.2.1.1.2 of Annex B4 to UN Regulation No 154. The dynamometer shall be adjusted to simulate the operation of a vehicle on the road at – 7 °C. Such adjustment may be based on a determination of the road load force profile at – 7 °C. Alternatively, the driving resistance determined may be adjusted for a 10 % decrease of the coast-down time. The technical service may approve the use of other methods for determining the driving resistance.'.

ANNEX VIII

In Annex IX to Regulation (EU) 2017/1151, Part A is replaced by the following:

'A. REFERENCE FUELS

The specification for the reference fuels to be used shall be those set out in Annex B3 to UN Regulation No 154.'.

ANNEX IX

'ANNEX XI

On-board diagnostics (OBD) for motor vehicles

1. INTRODUCTION

1.1. This Annex sets out the functional aspects of on-board diagnostic (OBD) systems for the control of emissions from motor vehicles.

2. GENERAL REQUIREMENTS

The requirements for OBD systems set out in paragraph 6.8. of UN Regulation No 154 shall apply for the purposes of this Annex.

3. ADMINISTRATIVE PROVISIONS FOR DEFICIENCIES OF OBD SYSTEMS

3.1. The administrative provisions for deficiencies of OBD systems as set out in Article 6(2) shall be those specified in Section 4 of Annex C5 to UN Regulation No 154 with the following exceptions.

3.2. Reference to "OBD thresholds" in paragraph 4.2.2. of Annex C5 to UN Regulation No 154 shall be understood as being reference to the OBD thresholds in Table 4A of paragraph 6.8.2. of UN Regulation No 154.

3.3. The second sub-paragraph of paragraph 4.6 of Annex C5 to UN Regulation No 154 shall be understood as being as follows:

"The type-approval authority shall notify its decision in granting a deficiency request in accordance with Article 6(2)."

4. TECHNICAL REQUIREMENTS

The definitions, requirements and tests for OBD systems set out in paragraph 3.10, 4, 5.10, 6.8 and Annex C5 to UN Regulation No 154 shall apply for the purposes of this Annex. The in-use performance requirements are specified in Appendix 1.

Appendix 1

IN-USE PERFORMANCE

1.1. **General Requirements**

The technical requirements and specifications shall be those set out in Appendix 1 to Annex 11 to UN/ECE Regulation No 83 with the exceptions and additional requirements as described in points 1.1.1 to 1.1.6.

1.1.1. The requirements of paragraph 7.1.5. of Appendix 1 to Annex 11 to UN/ECE Regulation No 83 shall be understood as being as follows.

For new type approvals and new vehicles the monitor required by paragraph 3.3.4.7. of Annex 11 to UN/ECE Regulation No 83 shall have an IUPR greater or equal to 0,1 until three years after the dates specified in Article 10(4) and (5) of Regulation (EC) No 715/2007 respectively.

1.1.2. The requirements of paragraph 7.1.7. of Appendix 1 to Annex 11 to UN/ECE Regulation No 83 shall be understood as being as follows.

The manufacturer shall demonstrate to the approval authority and, upon request, to the Commission that these statistical conditions are satisfied for all monitors required to be reported by the OBD system in accordance with paragraph 7.6. of Appendix 1 to Annex 11 to Regulation No 83 not later than 18 months after the entry onto the market of the first vehicle type with IUPR in an OBD family and every 18 months thereafter. For this purpose, for OBD families consisting of more than 1 000 registrations in the Union, that are subject to sampling within the sampling period, the process described in Annex II shall be used without prejudice to the provisions of paragraph 7.1.9. of Appendix 1 to Annex 11 to Regulation No 83.

In addition to the requirements set out in Annex II and regardless of the result of the audit described in Section 2 of Annex II, the authority granting the approval shall apply the in-service conformity check for IUPR described in Appendix 1 to Annex II in an appropriate number of randomly determined cases. 'In an appropriate number of randomly determined cases' means, that this measure has a dissuasive effect on non-compliance with the requirements of Section 3 of this Annex or the provision of manipulated, false or non-representative data for the audit. If no special circumstances apply and can be demonstrated by the type-approval authorities, random application of the in-service conformity check to 5 % of the type approved OBD families shall be considered as sufficient for compliance with this requirement. For this purpose, type-approval authorities may find arrangements with the manufacturer for the reduction of double testing of a given OBD family as long as these arrangements do not harm the dissuasive effect of the type-approval authority's own in-service conformity check on non-compliance with the requirements of Section 3 of this Annex. Data collected by Member States during surveillance testing programmes may be used for in-service conformity checks. Upon request, type-approval authorities shall provide data on the audits and random in-service conformity checks performed, including the methodology used for identifying those cases, which are made subject to the random in-service conformity check, to the Commission and other type-approval authorities.

1.1.3. Non-compliance with the requirements of paragraph 7.1.6. of Appendix 1 to Annex 11 to Regulation No 83 established by tests described in point 1.1.2 of this Appendix or paragraph 7.1.9 of Appendix 1 to Annex 11 to Regulation No 83 shall be considered as an infringement subject to the penalties set out in Article 13 of Regulation (EC) No 715/2007. This reference does not limit the application of such penalties to other infringements of other provisions of Regulation (EC) No 715/2007 or this Regulation, which do not explicitly refer to Article 13 of Regulation (EC) No 715/2007.

1.1.4. Paragraph 7.6.1. of Appendix 1 to Annex 11 to UN/ECE Regulation No 83 shall be replaced with the following:

"7.6.1. The OBD system shall report, in accordance with the standard listed in paragraph 6.5.3.2.(a) of Annex C5 to UN Regulation No 154, the ignition cycle counter and general denominator as well as separate numerators and denominators for the following monitors, if their presence on the vehicle is required by this Annex:

(a) Catalysts (each bank to be reported separately);

(b) Oxygen/exhaust gas sensors, including secondary oxygen sensors (each sensor to be reported separately);

(c) Evaporative system;

(d) EGR system;

(e) VVT system;

(f) Secondary air system;

(g) Particulate trap/filter;

(h) NO_x after-treatment system (e.g. NO_x absorber, NO_x reagent/catalyst system);

(i) Boost pressure control system."

1.1.5. Paragraph 7.6.2. of Appendix 1 to Annex 11 to UN/ECE Regulation No 83 shall be understood as follows:

"7.6.2. For specific components or systems that have multiple monitors, which are required to be reported by this point (e.g. oxygen sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD system shall separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator shall be reported for the specific component."

1.1.6. In addition to the requirements of paragraph 7.6.2. of Appendix 1 to Annex 11 to UN/ECE Regulation No 83 the following shall apply:

"Numerators and denominators for specific monitors of components or systems, that are monitoring continuously for short circuit or open circuit failures are exempted from reporting.

'Continuously,' if used in this context means monitoring is always enabled and sampling of the signal used for monitoring occurs at a rate no less than two samples per second and the presence or the absence of the failure relevant to that monitor has to be concluded within 15 seconds.

If for control purposes, a computer input component is sampled less frequently, the signal of the component may instead be evaluated each time sampling occurs.

It is not required to activate an output component/system for the sole purpose of monitoring that output component/system." '.

ANNEX X

In Annex XII to Regulation (EU) 2017/1151, point 2 is replaced by the following:

'2. DETERMINATION OF CO_2 EMISSIONS AND FUEL CONSUMPTION FROM VEHICLES SUBMITTED TO MULTI-STAGE TYPE-APPROVAL OR INDIVIDUAL VEHICLE APPROVAL

2.1. For the purpose of determining the CO_2 emissions and fuel consumption of a vehicle submitted to multi-stage type-approval, as defined in Article 3(8) of Regulation (EU) 2018/858, the procedures of Annex XXI apply. However, at the choice of the manufacturer and irrespective of the technically permissible maximum laden mass, the alternative described in paragraphs 2.2. to 2.6. may be used where the base vehicle is incomplete.

2.2. A road load matrix family, as defined in paragraph 6.3.4. of UN Regulation No 154, shall be established based on the parameters of a representative multi-stage vehicle in accordance with paragraph 4.2.1.4. of Annex B4 to UN Regulation No 154.

2.3. The manufacturer of the base vehicle shall calculate the road load coefficients of vehicle HM and LM of a road load matrix family as set out in paragraph 5. of Annex B4 to UN Regulation No 154 and shall determine the CO_2 emission and fuel consumption in a Type 1 test of both vehicles. The manufacturer of the base vehicle shall make available a calculation tool to establish, on the basis of the parameters of completed vehicles, the final fuel consumption and CO_2 values as specified in Annex B7 to UN Regulation No 154.

2.4. The calculation of road load and running resistance for an individual multi stage vehicle shall be performed in accordance with paragraph 5.1. of Annex B4 to UN Regulation No 154.

2.5. The final fuel consumption and CO_2 values shall be calculated by the final-stage manufacturer on the basis of the parameters of the completed vehicle as specified in paragraph 3.2.4. of Annex B7 to UN Regulation No 154 and using the tool supplied by the manufacturer of the base vehicle.

2.6. The manufacturer of the completed vehicle shall include, in the certificate of conformity, the information of the completed vehicles and add the information of the base vehicles in accordance with Commission Implementing Regulation (EU) 2020/683.

2.7. In the case of multi stage vehicles submitted to individual vehicle approval, the individual approval certificate shall include the following information:

(a) the CO_2 emissions measured in accordance with the methodology set out in points 2.1 to 2.6.;

(b) the mass of the completed vehicle in running order;

(c) the identification code corresponding to the type, variant and version of the base vehicle;

(d) the type-approval number of the base vehicle, including the extension number;

(e) the name and address of the manufacturer of the base vehicle;

(f) the mass of the base vehicle in running order.

2.8. In the case of multi stage type approvals or individual vehicle approval where the base vehicle is a complete vehicle with a valid certificate of conformity, the final stage manufacturer shall consult the base vehicle manufacturer to set the new CO_2 value in accordance with the CO_2 interpolation using the appropriate data from the completed vehicle or calculate the new CO_2 value on the basis of the parameters of the completed vehicle as specified in paragraph 3.2.4. of Annex B7 to UN Regulation No 154 and using the tool supplied by the manufacturer of the base vehicle as mentioned in point 2.3. If the tool is not available or the CO_2 interpolation is not possible, the CO_2 value of Vehicle High from the base vehicle shall be used with the agreement of the type-approval authority.'.

ANNEX XI

Annex XIII to Regulation (EU) 2017/1151 is amended as follows:

(1) point 3.2 is replaced by the following:

'3.2. This mark shall consist of a rectangle surrounding the lower-case letter "e" followed by the distinguishing number of the Member State which has granted the EC type-approval in accordance with the numbering system set out in Commission Implementing Regulation (EU) 2020/683.

The EC type- approval mark shall also include in the vicinity of the rectangle the "base approval number" contained in section 4 of the type-approval number referred to in Annex IV to Commission Implementing Regulation (EU) 2020/683, preceded by the two figures indicating the sequence number assigned to the latest major technical amendment to Regulation (EC) No 715/2007 or this Regulation on the date EC type-approval for a separate technical unit was granted. For this Regulation, the sequence number is 00.';

(2) point 4 is replaced by the following:

'4. TECHNICAL REQUIREMENTS

4.1. The requirements for the type-approval of replacement pollution control devices shall be those of Section 5 of UN/ECE Regulation No 103[1] with the exceptions set out in sections 4.1.1 to 4.1.5.

4.1.1. Reference to the 'test cycle' in Section 5 of UN/ECE Regulation No 103 shall be understood as being the same Type I / Type 1 test and Type I / Type 1 test cycle as used for the original type approval of the vehicle.

4.1.2. The terms 'catalytic converter' and 'converter' used in section 5 of UN/ECE Regulation No 103 shall be understood to mean 'pollution control device'

4.1.3. The regulated pollutants referred to throughout section 5.2.3 of UN/ECE Regulation No 103 shall be replaced by all the pollutants specified in Annex 1, Table 2 of Regulation (EC) No 715/2007 for replacement pollution control devices intended to be fitted to vehicles type approved to Regulation (EC) No 715/2007.

4.1.4. For replacement pollution control devices intended to be fitted to vehicles type approved to Regulation (EC) No 715/2007, the durability requirements and associated deterioration factors specified in section 5 of UN/ECE Regulation No 103, shall refer to those specified in Annex VII to this Regulation.

4.2. For vehicles with positive-ignition engines, if the NMHC emissions measured during the demonstration test of a new original equipment catalytic converter, under paragraph 5.2.1 of UN/ECE Regulation No 103, are higher than the values measured during the type-approval of the vehicle, the difference shall be added to the OBD thresholds. The OBD thresholds are specified in Table 4A of UN Regulation No 154.

4.3. The revised OBD thresholds will apply during the tests of OBD compatibility set out in paragraphs 5.5 to 5.5.5 of UN/ECE Regulation No 103. In particular, when the exceedance allowed in paragraph 1 of Appendix 1 to Annex C5 to UN Regulation No 154 is applied.

4.4. Requirements for replacement periodically regenerating systems

4.4.1. Requirements regarding emissions

4.4.1.1. The vehicle(s) indicated in Article 11(3), equipped with a replacement periodically regenerating system of the type for which approval is requested, shall be subject to the tests described in Appendix 1 to Annex B6 to UN Regulation No 154, in order to compare its performance with the same vehicle equipped with the original periodically regenerating system.

4.4.1.2. Reference to the 'Type I test' and 'Type I test cycle' in Appendix 1 to Annex B6 to UN Regulation No 154 and the 'test cycle' in Section 5 of UN/ECE Regulation No 103 shall be understood as being the same Type I / Type 1 test and Type I / Type 1 test cycle as used for the original type approval of the vehicle.

4.4.2. Determination of the basis for comparison

4.4.2.1. The vehicle shall be fitted with a new original periodically regenerating system. The emissions performance of this system shall be determined following the test procedure set out in Appendix 1 to Annex B6 to UN Regulation No 154.

4.4.2.1.1. Reference to the 'Type I test' and 'Type I test cycle' in Appendix 1 to Annex B6 to UN Regulation No 154 and the 'test cycle' in Section 5 of UN/ECE Regulation No 103 shall be understood as being the same Type I / Type 1 test and Type I / Type 1 test cycle as used for the original type approval of the vehicle.

4.4.2.2. Upon request of the applicant for the approval of the replacement component, the approval authority shall make available on a non-discriminatory basis, the information referred to in point 3.2.12.2.10.2. of the information document contained in Appendix 3 to Annex I to this Regulation for each vehicle tested.

4.4.3. Exhaust gas test with a replacement periodically regeneration system

4.4.3.1. The original equipment periodically regenerating system of the test vehicle(s) shall be replaced by the replacement periodically regenerating system. The emissions performance of this system shall be determined following the test procedure set out in Appendix 1 to Annex B6 to UN Regulation No 154.

4.4.3.1.1. Reference to the 'Type I test' and 'Type I test cycle' in Appendix 1 to Annex B6 to UN Regulation No 154 and the 'test cycle' in Section 5 of UN/ECE Regulation No 103 shall be understood as being the same Type I / Type 1 test and Type I / Type 1 test cycle as used for the original type approval of the vehicle.

4.4.3.2. To determine the D-factor of the replacement periodically regenerating system, any of the engine test bench methods referred to in Appendix 1 to Annex B6 to UN Regulation No 154 may be used.

4.4.4. Other requirements

The requirements provided in paragraphs 5.2.3, 5.3, 5.4 and 5.5 of UN/ECE Regulation No 103 shall apply to replacement periodically regenerating systems. In these paragraphs the words 'catalytic converter' shall be understood to mean 'periodically regenerating system'. The exceptions provided in the paragraphs in section 4.1 of this Annex shall also apply to periodically regenerating systems.'.

ANNEX XII

'ANNEX XVI

Requirements for vehicles that use a reagent for the exhaust after-treatment system

1. INTRODUCTION

This Annex sets out the requirements for vehicles that rely on the use of a reagent for the after-treatment system in order to reduce emissions.

2. GENERAL REQUIREMENTS

The general requirements for vehicles that use a reagent for the exhaust after-treatment system shall be those set out in paragraph 6.9. of UN Regulation No 154.

3. TECHNICAL REQUIREMENTS

The technical requirements for vehicles that use a reagent for the exhaust after-treatment system shall be those set out in Appendix 6 to UN Regulation No 154.

3.1. The reference to Annex A1 in paragraph 4.1. of Appendix 6 to UN Regulation No 154 shall be understood as reference to Appendix 3 of Annex I to this Regulation.'.

ANNEX XIII

Annex XX to Regulation (EU) 2017/1151 is amended as follows:

(1) Footnote 1 is replaced by the following: 'OJ L 323, 7.11.2014, p. 52.'.

(2) The following sentence is added to point 1:

'The latter in case of electric drive trains composed of controllers and motors, which are used as the sole mode of propulsion, at least for part of the time.'.

ANNEX XIV

'ANNEX XXI

Type 1 emissions test procedures

1. INTRODUCTION

This Annex describes the procedure for determining the levels of emissions of gaseous compounds, particulate matter, particle number, CO_2 emissions, fuel consumption, electric energy consumption and electric range from light-duty vehicles.

2. GENERAL REQUIREMENTS

2.1. The general requirements for conducting the type 1 test shall be those set out in UN Regulation No 154.

2.2. The limit values referred to in Table 1A of paragraph 6.3.10 of UN Regulation No 154 shall be replaced by the limit values set out in Annex I, Table 2, to Regulation (EC) No 715/2007.

3. TECHNICAL REQUIREMENTS

The technical requirements for conducting the type 1 test shall be those set out in paragraph 6.3. and Annexes Part B of UN Regulation No 154, with the exceptions described in the points below.

3.1. Table A4/2 in paragraph 4.2.2.1. of Annex B4 to UN Regulation No 154 shall read as follows:

Energy efficiency class	Range of RRC for C1 tyres	Range of RRC for C2 tyres	Range of RRC for C3 tyres
A	RRC ≤ 6,5	RRC ≤ 5,5	RRC ≤ 4,0
B	6,6 ≤ RRC ≤ 7,7	5,6 ≤ RRC ≤ 6,7	4,1 ≤ RRC ≤ 5,0
C	7,8 ≤ RRC ≤ 9,0	6,8 ≤ RRC ≤ 8,0	5,1 ≤ RRC ≤ 6,0
D	9,1 ≤ RRC ≤ 10,5	8,1 ≤ RRC ≤ 9,0	6,1 ≤ RRC ≤ 7,0
E	RRC ≥10,6	RRC ≥ 9,1	RRC ≥ 7,1
Energy efficiency class	Value of RRC to be used for interpolation for C1 tyres	Value of RRC to be used for interpolation for C2 tyres	Value of RRC to be used for interpolation for C3 tyres
A	RRC = 5,9 (*)	RRC = 4,9 (*)	RRC = 3,5 (*)
B	RRC = 7,1	RRC = 6,1	RRC = 4,5
C	RRC = 8,4	RRC = 7,4	RRC = 5,5
D	RRC = 9,8	RRC = 8,6	RRC = 6,5
E	RRC = 11,3	RRC = 9,9	RRC = 7,5

(*) In case the actual RRC value is lower than this value, the actual rolling resistance value of the tyre or any higher value up to the RRC value indicated here shall be used for interpolation.

3.2. Appendix 5 of Annex B8 to UN Regulation No 154 shall be read as:

Appendix 5

Utility factors (UF) for OVC-HEVs and OVC-FCHVs (as applicable)

1. Reserved

2. For the approval of OVC-HEVs or OVC-FCHVs of category M1 or N1 with emission characters EA, EB or EC as referred to in Table 1, Appendix 6 to Annex I, the fractional utility factor UF_j for the weighting of period j, shall be calculated in accordance with the following equation:

$$UF_j(dj) = 1 - \exp\left\{-\left(\sum_{i=1}^{k} C_i \times \left(\frac{d_j}{d_{nx}}\right)^i\right)\right\} - \sum_{i=1}^{j-1} UF_1$$

where:

UF_j utility factor for period j;

d_j measured distance driven at the end of period j, km;

C_i i^{th} coefficient (see Table A8.App5/1);

d_{nx} d_{nea}, d_{neb}, d_{nec}, normalized distance (see Table A8.App5/1);

k number of terms and coefficients in the exponent;

j number of period considered;

i number of considered term/coefficient;

$\sum_{i=1}^{j-1} UF_1$ sum of calculated utility factors up to period (j-1)

The normalized distance "d_{nx}" shall be set in accordance with the Table A8.App5/1, where the values d_{neb} shall be applied from 1 January 2025, and d_{nec} from 1 January 2027.

The value d_{nec} shall, where appropriate, be revised at the latest by 31 December 2024, taking into account the real-world fuel consumption data recorded by fuel consumption monitoring devices on-board OVC-HEVs or OVC-FCHVs and made available pursuant to Implementing Regulation (EU) 2021/392.

Table A8.App5/1

Parameters for the determination of fractional UFs (as applicable)

Parameter	Value
d_{nea} (*)	800 km
d_{neb} (*)	2 200 km
d_{nec} (*)	4 260 km
C1	26,25
C2	– 38,94
C3	– 631,05
C4	5 964,83
C5	– 25 095

Parameter	Value
C6	60 380,2
C7	– 87 517
C8	75 513,8
C9	– 35 749
C10	7 154,94

(*) The value to be applied shall be that corresponding to the emission characters EA, EB and EC as specified in Table 1, Appendix 6 to Annex I.'.

ANNEX XV

'ANNEX XXII

Devices for monitoring on board the vehicle the consumption of fuel and/or electric energy

1. INTRODUCTION

This Annex sets out the definitions and requirements applicable to the devices for monitoring on board the vehicle the consumption of fuel and/or electric energy.

2. GENERAL REQUIREMENTS

The general requirements for OBFCM devices shall be those set out in paragraph 6.3.9. of UN Regulation No 154.

3. TECHNICAL REQUIREMENTS

The technical requirements for the OBFCM device shall be those set out in Appendix 5 to UN Regulation No 154.'