Vehicle Standard (Australian Design Rule 114/00 – Carbon Dioxide Emissions Measurement) 2026

I, CATHERINE KING, Minister for Infrastructure, Transport, Regional Development and Local Government determine this national road vehicle standard under section 12 of the *Road Vehicle Standards Act 2018*.

Dated: 2026

[DRAFT – NOT FOR SIGNATURE]

Catherine King

Minister for Infrastructure, Transport, Regional Development and Local Government

DRAFT FOR CONSULTATION

Contents

1. LEGISLATIVE PROVISIONS

1.1. Name of Standard

1.1.1. This standard is the Vehicle Standard (Australian Design Rule 114/00 – Carbon Dioxide Emissions Measurement) 2026.

1.1.2. This standard may also be cited as Australian Design Rule 114/00 – Carbon Dioxide Emissions Measurement, the Australian Design Rule 114/00, or ADR 114/00.

1.2. Commencement

1.2.1. This standard commences on the day after it is registered.

2. FUNCTION

2.1 This vehicle standard prescribes the requirements for determining a vehicles' carbon dioxide emissions number for the purposes of the *New Vehicle Efficiency Standard Act 2024* if a vehicle has a gross vehicle mass exceeding 3,500kg.

3. APPLICABILITY

3.1. Subject to 3.2 and 3.3, this vehicle standard applies to MA, MB, MC, and NB category vehicles with a gross vehicle mass exceeding 3,500kg but not exceeding 3,855kg supplied from 1 January 2027.

3.2 Vehicles that comply with ADR 81/03 need not comply with this vehicle standard.

3.3. NB1 category vehicles need not comply with this vehicle standard, if the vehicle:

3.3.1 has an integrated and enclosed space designed for the carriage of passengers and goods, and the area designed for the carriage of goods exceeds 50.0 per cent of the vehicle's *'Total Length'*; or

3.3.2 is a 'chassis-cab' with one row of seats, and is designed to be fitted with a body designed for the carriage of goods and/or equipment for non-passenger transport purposes exceeding 60.0 per cent of the vehicle's *'Total Length'*, including the maximum *'Rear Overhang'* permitted under Clause 6.1.2.1 of the Vehicle Standard (Australian Design Rule 43/04 – Vehicle Configuration and Dimensions) 2006; or

3.3.3 is a 'chassis-cab' with two or more row of seats, and is designed to be fitted with a body designed for the carriage of goods and/or equipment for non-passenger transport purposes exceeding 50.0 per cent of the vehicle's *'Total Length'*, including the maximum *'Rear Overhang'* permitted under Clause 6.1.2.1 of the Vehicle Standard (Australian Design Rule 43/04 – Vehicle Configuration and Dimensions) 2006; or

3.3.4 is a vehicle with one row of seats and fitted with a body designed for the carriage of goods and/or equipment for non-passenger transport purposes exceeding 60.0 per cent of the vehicle's *'Total Length'*; or

3.3.5 is a vehicle with two or more rows of seats and fitted with a body designed for the carriage of goods and/or equipment for non-passenger transport purposes exceeding 50.0 per cent of the vehicle's *'Total Length'*.

3.4 Applicability Table

Vehicle Category	**ADR Category Code**	**UN Category Code***	**Manufactured on or After**	**Acceptable Prior Rules**
Moped 2 wheels	LA	L1	Not Applicable	
Moped 3 wheels	LB	L2	Not Applicable	
Motor cycle	LC	L3	Not Applicable	
Motor cycle and sidecar	LD	L4	Not Applicable	
Motor tricycle	LE	L5		
	LEM		Not Applicable	
	LEP		Not Applicable	
	LEG		Not Applicable	
Passenger car	MA	M1	See clause 3.1	Nil
Forward-control passenger vehicle	MB	M1	See clause 3.1	Nil
Off-road passenger vehicle	MC	M1	See clause 3.1	Nil
Light omnibus	MD	M2		
up to 3.5 tonnes '*GVM'* and up to 12 seats	MD1		Not Applicable	
up to 3.5 tonnes *'GVM'* and more than 12 seats	MD2		Not Applicable	
over 3.5 tonnes and up to 4.5 tonnes *'GVM'*	MD3		Not Applicable	
over 4.5 tonnes and up to 5 tonnes *'GVM'*	MD4		Not Applicable	
Heavy omnibus	ME	M3	Not Applicable	

Vehicle Category	ADR Category Code	UN Category Code*	Manufactured on or After	Acceptable Prior Rules
Light goods vehicle	NA	N1	Not Applicable	
Medium goods vehicle	NB	N2		
over 3.5 tonnes up to 4.5 tonnes *'GVM'*	NB1		See clause 3.1**	Nil
over 4.5 tonnes up to 12 tonnes *'GVM'*	NB2		Not Applicable	
Heavy goods vehicle	NC	N3	Not Applicable	
Very light trailer	TA	O1	Not Applicable	
Light trailer	TB	O2	Not Applicable	
Medium trailer	TC	O3	Not Applicable	
Heavy trailer	TD	O4	Not Applicable	

* The category code may also be in the format L_1, L_2, L_3 etc
**Vehicle types specified in Clause 3.3 excepted.

4. DEFINITIONS

4.1. *Supporting Information* has the same meaning as in the Road Vehicle Standards Rules 2019.

4.2 For all other vehicle categories, definitions and meanings used in this standard, refer to Appendix A of this vehicle standard.

4.3 If a term is not defined in Appendix A, refer to the Vehicle Standard (Australian Design Rule 111/00 – Advanced Emission Control for Light Vehicles) 2024.

4.4. If the term is not defined in Appendix A or ADR 111/00, refer to the Vehicle Standard (Australian Design Rule – Definitions and Vehicle Categories) 2005.

5. REQUIREMENTS

5.1 All vehicles must have their carbon dioxide emissions tested in accordance with Appendix A or one of the alternative standards specified in clause 7.

5.2 If the vehicle has been tested in accordance with Appendix A or the alternative standard specified in clause 7.1, the manufacturer must record the following in their '*Supporting Information*':

5.2.1 The carbon dioxide emissions value declared for the vehicle (in grams per kilometre); and

5.2.2 The carbon dioxide emissions measured for the vehicle over the complete Type I test cycle (in grams per kilometre); and

5.2.3 If the vehicle is an *OVC-HEV*, the manufacturer must also record:

5.2.3.1 The carbon dioxide emissions value declared for the vehicle in charge sustaining mode (in grams per kilometre); and

5.2.3.2. The carbon dioxide emissions measured for the vehicle in charge sustaining mode over the complete Type I test cycle (in grams per kilometre); and

5.2.3.3 The OVC range declared for the vehicle (in kilometres); and

5.2.3.4 The OVC range measured for the vehicle (in kilometres).

5.3 If the vehicle has been tested in accordance with one of the alternative standards specified in clause 7.2, 7.3, 7.4 or 7.5, the manufacturer must record the following in their *'Supporting Information'*:

5.3.1 The carbon dioxide emissions value declared for the vehicle in accordance with that standard (in grams per kilometre); and

5.3.2 The carbon dioxide emissions measured for the vehicle in accordance with that standard (in grams per kilometre); and

5.3.3 The 'NEDC equivalent' carbon dioxide emissions value calculated for the vehicle in accordance with Appendix B (in grams per kilometre); and

5.3.4 If the vehicle is an *OVC-HEV*, the manufacturer must also record:

5.3.4.1 The carbon dioxide emissions value declared for the vehicle in accordance with that standard in charge sustaining mode (in grams per kilometre); and

5.3.4.2. The carbon dioxide emissions measured for the vehicle in accordance with that standard in charge sustaining mode over the complete Type I test cycle (in grams per kilometre); and

5.3.4.3 The NEDC equivalent carbon dioxide emissions value in charge sustaining mode calculated for the vehicle in accordance with Appendix B (in grams per kilometre); and

5.3.4.4 The equivalent all electric range declared for the vehicle in accordance with that standard (in kilometres); and

5.3.4.5 The equivalent all electric range measured for the vehicle with that standard (in kilometres).

6. EXEMPTIONS AND ALTERNATIVE PROCEDURES

6.1 The following sections and annexes of Appendix A are not applicable for the purposes of this vehicle standard:

Section 1	Scope
Section 3	Application for Approval
Section 4	Approval
Section 6	Modification and extension of approval of the approved type
Section 8	Special provisions
Section 9	Conformity of Production

Section 10	Penalties for non-conformity of production
Section 11	Production definitely discontinued
Section 12	Names and addresses of technical services responsible for conducting approval tests and of administrative departments
Section 13	Transitional provisions
Annex 1	Essential characteristics of the vehicle powered by an internal combustion engine only and information concerning the conduct of tests
Annex 2	Essential characteristics of the vehicle powered by an electric power train only and information concerning the conduct of tests
Annex 3	Essential characteristics of the vehicle powered by a hybrid electric power train and information concerning the conduct of tests
Annex 4	Communication
Annex 5	Arrangements of approval marks

6.2 References to ‘Regulation No. 83’ in Appendix A are amended to read ‘Appendix A of ADR 79/04’.

7. ALTERNATIVE STANDARDS

7.1 Subject to 7.1.1, the technical requirements of United Nations (UN) Regulation No. 101 - *Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M_1 and N_1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range*, incorporating all amendments up to and including Supplement 12 to the 01 series of amendments or later.

7.1.1 Notwithstanding the scope of UN Regulation No. 101, testing may be performed in accordance with this regulation on vehicles with a reference mass exceeding 2,610kg or gross vehicle mass over 3,500kg, to comply with this vehicle standard.

7.2 The technical requirements of Annexes B1 to B8 of United Nations 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)*.

7.3 The technical requirements of Annex XXI of Commission Regulation (EC) 2017/1151 of the European Parliament and of the Council of 1 June 2017 supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and repealing Commission Regulation (EC) No 692/2008.

7.4 The technical requirements of Annex XXI of Commission Implementing Regulation (EU) 2025/1706 of 25 July 2025 laying down rules, procedures and testing methodologies for the application of Regulation (EU) 2024/1257 as regards exhaust and evaporative emission type-approval of vehicles of categories M1 and N1 and amending Implementing Regulation (EU) 2020/683.

7.5. The technical requirements of the ‘Federal Test Procedure’ and the ‘Highway Fuel Economy Test’ specified in Title 40 of the United States Code of Federal Regulations (CFR), Part 600, Fuel Economy and Greenhous Gas Exhaust Emissions of Motor Vehicles.

APPENDIX A

UN Regulation No. 101

Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M_1 and N_1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range

Incorporating by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts all valid text up to:
Supplement 2 to the 01 series of amendments – Date of entry into force: 15 July 2013
Supplement 3 to the 01 series of amendments – Date of entry into force: 10 June 2014
Supplement 4 to the 01 series of amendments – Date of entry into force: 22 January 2015
Supplement 5 to the 01 series of amendments – Date of entry into force: 20 January 2016
Supplement 6 to the 01 series of amendments – Date of entry into force: 18 June 2016
Supplement 7 to the 01 series of amendments – Date of entry into force: 10 October 2017
Supplement 8 to the 01 series of amendments – Date of entry into force: 28 May 2019
Supplement 9 to the 01 series of amendments – Date of entry into force: 3 January 2021
Supplement 10 to the 01 series of amendments – Date of entry into force: 7 January 2022
Supplement 11 to the 01 series of amendments – Date of entry into force: 22 June 2022
Supplement 12 to the 01 series of amendments – Date of entry into force 5 January 2024

Regulation No. 101

Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M_1 and N_1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range

Contents

1. Scope

This Regulation applies to vehicles of categories M_1 and N_1[1] with regard to:

(a) The measurement of the emission of carbon dioxide (CO_2) and fuel consumption and/or to the measurement of electric energy consumption and electric range of vehicles powered by an internal combustion engine only or by a hybrid electric power train,

(b) And to the measurement of electric energy consumption and electric range of vehicles powered by an electric power train only.

It does not apply to a category N_1 vehicle if both:

(a) The engine type fitted to that type of vehicle has received type approval pursuant to Regulation No. 49, and

(b) The total annual worldwide production of N_1 vehicles of the manufacturer is less than 2,000 units.

2. Definitions

For the purposes of this Regulation,

2.1. "*Approval of a vehicle*" means the approval of a vehicle type with regard to the measurement of energy consumption (fuel or electric energy);

2.2. "*Vehicle type*" means a category of power driven vehicles which do not differ in such essential respects as body, power train, transmission, traction battery (if applicable), tyres and unladen mass;

2.3. "*Unladen mass*" means the mass of the vehicle in running order without crew, passengers or load, but with the fuel tank full (if any), cooling liquid, service and traction batteries, oils, onboard charger, portable charger, tools and spare wheel, whatever is appropriate for the vehicle considered and if provided by the manufacturer of the vehicle;

2.4. "*Reference mass*" means the unladen mass of the vehicle increased by a uniform figure of 100 kg;

2.5. "*Maximum mass*" means the technically permissible maximum mass declared by the manufacturer (this mass may be greater than the maximum mass authorized by the national administration);

2.6. "*Test mass*" for the pure electric vehicles, means the "reference mass" for the category M_1 vehicles and the unladen mass plus half the full load for the category N_1 vehicles;

2.7. "*Lorry*" means a motor vehicle of category N_1 which is designed and constructed exclusively or principally for conveying goods;

2.8. "*Van*" means a lorry with the cab integrated into the body;

2.9. "*Cold start device*" means a device which enriches the air/fuel mixture of the engine temporarily, to assist starting;

[1] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.),

document ECE/TRANS/WP.29/78/Rev.2, para. 2.

2.10. "*Starting aid*" means a device which assists engine starting without enrichment of the air/fuel mixture, e.g. glow plug, changed injection timing, etc.;

2.11. "*Power train*" means the system of energy storage device(s), energy converter(s) and transmission(s) that converts stored energy to mechanical energy delivered at the wheels for propulsion of the vehicle;

2.12. "*Internal combustion engine vehicle*" means vehicle powered by an internal combustion engine only;

2.13. "*Electric power train*" means a system consisting of one or more electric energy storage devices (e.g. a battery, electromechanical flywheel or super capacitor), one or more electric power conditioning devices and one or more electric machines that convert stored electric energy to mechanical energy delivered at the wheels for propulsion of the vehicle;

2.14. "*Pure electric vehicle*" means vehicle powered by an electric power train only;

2.15. "*Hybrid power train*" means a power train with at least two different energy converters and two different energy storage systems (on-board the vehicle) for the purpose of vehicle propulsion;

2.15.1. "*Hybrid electric power train*" means a power train that, for the purpose of mechanical propulsion, draws energy from both of the following on-vehicle sources of stored energy/power:

- A consumable fuel
- An electrical energy/power storage device (e.g.: battery, capacitor, flywheel/generator ...)

2.16. "*Off-Vehicle Charging (OVC) range*" means the total distance covered during complete combined cycles run until the energy imparted by external charging of the battery (or other electric energy storage device) is depleted, as measured according to the procedure described in Annex 9 to this Regulation.

2.17. "*Hybrid Vehicle (HV)*" means a vehicle powered by a hybrid power train;

2.17.1. "*Hybrid electric vehicle (HEV)*" means a vehicle, including vehicles which draw energy from a consumable fuel only for the purpose of re-charging the electrical energy/power storage device, that, for the purpose of mechanical propulsion, draws energy from both of the following on-vehicle sources of stored energy/power:

(a) A consumable fuel;

(b) A battery, capacitor, flywheel/generator or other electrical energy/power storage device;"

2.18. "*Electric range*", for vehicles powered by an electric power train only or by a hybrid electric power train with off-vehicle charging, means distance that can be driven electrically on one fully charged battery (or other electric energy storage device) as measured according to the procedure described in Annex 7 and Annex 9 to this Regulation.

2.19. "*Periodically regenerating system*" means an anti-pollution device (e.g. catalytic converter, particulate trap) that requires a periodical regeneration

process in less than 4,000 km of normal vehicle operation. If a regeneration of an anti-pollution device occurs at least once per Type I test and that has already regenerated at least once during the vehicle preparation cycle, it will be considered as a continuously regenerating system, which does not require a special test procedure. Annex 10 to this Regulation does not apply to continuously regenerating systems.

At the request of the manufacturer, the test procedure specific to periodically regenerating systems will not apply to a regenerative device if the manufacturer provides data to the Type Approval Authority that, during cycles where regeneration occurs, emission of CO_2 does not exceed the declared value by more than 4 per cent after agreement of the Technical Service.

2.20. "*Flex fuel H2NG vehicle*" means a flex fuel vehicle that can run on different mixtures of hydrogen and NG/biomethane;

2.21. "*Hydrogen fuel cell vehicle*" means a vehicle powered by a fuel cell that converts chemical energy from hydrogen into electric energy, for propulsion of the vehicle.

3. Application for approval

3.1. The application for approval of a vehicle type with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or to the measurement of electric energy consumption and electric range shall be submitted by the vehicle manufacturer or by his duly accredited representative.

3.2. It shall be accompanied by the under-mentioned documents in triplicate and the following particulars:

3.2.1. A description of the essential characteristics of the vehicle comprising all the particulars referred to in Annex 1, Annex 2 or Annex 3 to this Regulation, depending on the power train type. At the request of the Technical Service in charge of the tests or the manufacturer, complementary technical information could be considered for specific vehicles which are particularly fuel efficient.

3.2.2. Description of the basic features of the vehicle, including those used in drafting Annex 4 to this Regulation.

3.3. A vehicle, representative of the vehicle type to be approved, shall be submitted to the Technical Services responsible for conducting approval tests. For M_1 and N_1 vehicles, type-approved with respect to their emissions according to Regulation No. 83, the Technical Service will check during the test that this vehicle, if powered by an internal combustion engine only or by a hybrid electric power train, conforms to the limit values applicable to that type, as described in Regulation No. 83.

3.4. The Type Approval Authority shall verify the existence of satisfactory provisions to ensure an effective check of conformity of production before approval of the vehicle type is granted.

4. Approval

4.1. If the emissions of CO_2 and fuel consumption and/or the electric energy consumption and electric range of the vehicle type submitted for approval pursuant to this Regulation have been measured according to the conditions specified in paragraph 5. below, approval of that vehicle type shall be granted.

4.2. An approval number shall be assigned to each type approved. Its first two digits shall indicate the series of amendments (at present 01) incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another vehicle type.

4.3. Notice of approval or of extension or refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Contracting Parties to the 1958 Agreement applying this Regulation by means of a form conforming to the model in Annex 4 to this Regulation.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation, an international approval mark consisting of:

4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval[2];

4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1. above.

4.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. above need not be repeated; in such a case, the Regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1. above.

4.6. The approval mark shall be clearly legible and be indelible.

4.7. The approval mark shall be placed close to or on the vehicle data plate.

4.8. Annex 5 to this Regulation gives examples of arrangements of the approval mark.

5. Specifications and tests

5.1. General

5.1.1. The components liable to affect the emissions of CO_2 and fuel consumption or the electric energy consumption shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibrations to which it may be subjected, to comply with the provisions of this Regulation.

5.1.2. The vehicle to be tested shall be equipped with the daytime running lamp system that has the highest electrical energy consumption of the daytime running lamp systems, which are fitted by the manufacturer to vehicles in the

group represented by the type-approved vehicle. The manufacturer shall supply appropriate technical documentation to the type-approval authorities in this respect.

[2] The distinguish numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev.2/Amend.3.

The daytime running lamps as defined in paragraph 2. of Regulation No. 48 shall be switched ON during the test cycle.

5.1.2.1. For tests according to this Regulation performed after 5 January 2024, the rear position lamps shall be set to the operating condition which is applied at ambient lighting conditions exceeding 7,000 lux (e.g. by the vehicle's dynamometer operation mode).

5.1.3. Table A illustrates the application of the test requirements for type approval of a vehicle.

Table A

Application of the test requirements: CO_2 emissions, fuel consumption, electric energy consumption and electric range

Vehicles with positive ignition engines including hybrids			*Test required*
Mono fuel	Petrol (E5/E10)[3]		Yes
	LPG		Yes
	NG/Biomethane		Yes
	Hydrogen		Yes
Bi-fuel[1]	Petrol (E5/E10)[3]	LPG	Yes (both fuels)
	Petrol (E5/E10)[3]	NG/Biomethane	Yes (both fuels)
	Petrol (E5/E10)[3]	Hydrogen	Yes (both fuels)
Flex-fuel[1]	Petrol (E5/E10)[3]	Ethanol (E85)	Yes (both fuels)
	NG/Biomethane	H2NG	Yes (both fuels)
Vehicles with compression ignition engines including hybrids			*Test required*
Flex fuel	Diesel (B5/B7)[3]	Biodiesel	Yes (B5/B7 only)[2,3]
Mono fuel	Diesel (B5/B7)[3]		Yes
Other vehicles			*Test required*
Pure electric vehicles			Yes
Hydrogen Fuel cell vehicles			Yes

Notes:

[1] When a bi-fuel vehicle is combined with a flex fuel vehicle, both test requirements are applicable.

[2] This provision is temporary, further requirements for biodiesel shall be proposed later on.

[3] Upon the choice of the manufacturer vehicles, with positive and compression ignition engines may be tested with either E5 or E10 and either B5 or B7 fuels, respectively. However:

(a) not later than sixteen months after the dates set out in paragraph 12.2.1. of Regulation No. 83, new type approvals shall only be performed with E10 and B7 fuels;

(b) not later than as from dates set out in paragraph 12.2.4. of Regulation No. 83, all new vehicles shall be approved with E10 and B7 fuels.

5.2. Description of tests for vehicles powered by an internal combustion engine only

5.2.1. The emissions of CO_2 and fuel consumption shall be measured according to the test procedure described in Annex 6 to this Regulation. Vehicles which do not attain the acceleration and maximum speed values required in the test cycle must be operated with the accelerator control fully depressed until they once again reach the required operating curve. Deviations from the test cycle must be recorded in the test report.

5.2.2. For CO_2 emissions the results of the test must be expressed in grams per kilometre (g/km) rounded to the nearest whole number.

5.2.3. Fuel consumption values must be expressed in litres per 100 km (in the case of petrol (E5/E10), LPG, ethanol (E85) and diesel (B5/B7)), in m^3 per 100 km (in the case of NG/biomethane and H2NG) or in kg per 100 km (in the case of hydrogen) and are calculated according to paragraph 1.4.3. of Annex 6. The results will be rounded to the first decimal place.

5.2.4. For the purpose of the calculation mentioned in paragraph 5.2.3., the fuel consumption shall be expressed in appropriate units and the following fuel characteristics shall be used:

(a) Density: measured on the test fuel according to ISO 3675 or an equivalent method. For petrol (E5/E10), diesel (B5/B7), biodiesel and ethanol (E85 and E75) the density measured at 15 ºC will be used; for LPG and natural gas/biomethane a reference density will be used, as follows:

0.538 kg/litre for LPG

0.654 kg/m^3 for NG [3];

(b) Hydrogen-carbon ratio: fixed values will be used which are:

$C_1H_{1.89}O_{0.016}$ for petrol (E5);

$C_1H_{1.93}O_{0.033}$ for petrol (E10);

$C_1H_{1.86}O_{0.005}$ for diesel (B5);

$C_1H_{1.86}O_{0.007}$ for diesel (B7);

$C_1H_{2.525}$ for LPG (liquefied petroleum gas);

CH_4 for NG (natural gas) and biomethane;

$C_1H_{2.74}O_{0.385}$ for ethanol (E85);

C_1 $H_{2.61}$ $O_{0.329}$ for ethanol (E75).

5.3. Description of tests for vehicles powered by an electric power train only

5.3.1. The Technical Service in charge of the tests conducts the measurement of the electric energy consumption and electric range according to the method and test cycle described in Annex 7 to this Regulation.

5.3.2. The pure electric range D_e measured by this method is the only one which may be included in sales promotional material.

5.3.3. The result of the electric energy consumption C must be expressed in Watt hours per kilometre (Wh/km) and the range in km, both rounded to the nearest whole number.

5.4. Description of tests for vehicles powered by a hybrid electric power train

5.4.1. The Technical Service in charge of the tests conducts the measurement of the emissions of CO_2 and of the electric energy consumption according to the test procedure described in Annex 8 to this Regulation.

5.4.2. The results of the test for CO_2 emissions must be expressed in grams per kilometre (g/km) rounded to the nearest whole number.

5.4.3. Fuel consumption values must be expressed in litres per 100 km (in the case of petrol, LPG or diesel) or in m^3 per 100 km (in the case of NG), and are calculated according to paragraph 1.4.3. of Annex 6 to this Regulation by the carbon balance method using the measured emissions of CO_2 and the other carbon related emissions (CO and HC). The results will be rounded to the first decimal place.

5.4.4. For the purpose of the calculation mentioned in paragraph 5.4.3. above, the prescriptions and values of paragraph 5.2.4. above shall apply.

5.4.5. If applicable, the result of the electric energy consumption must be expressed in Watt hours per kilometre (Wh/km), rounded to the nearest whole number.

5.4.6. The Technical Service in charge of the tests conducts the measurement of the electric range of the vehicle according to the method described in Annex 9 to this Regulation. The result shall be expressed in km, rounded to the nearest whole number.

The electric range measured by this method is the only one which may be included in sales promotional material and which may be used for the calculations of Annex 8 to this Regulation.

5.5. Interpretation of results

5.5.1. The CO_2 value or the value of electric energy consumption adopted as the type approval value shall be the value declared by the manufacturer if the value measured by the Technical Service does not exceed the declared value by more than 4 per cent. The measured value can be lower without any limitations.

In the case of vehicles powered by an internal combustion engine only which are equipped with periodically regenerating systems as defined in paragraph 2.16. of this Regulation, the results are multiplied by the factor K_i obtained from Annex 10 to this Regulation before being compared to the declared value.

5.5.2. If the measured value of CO_2 or electric energy consumption exceeds the manufacturer's declared CO_2 or electric energy consumption value by more than 4 per cent, then another test is run on the same vehicle.

When the average of the two test results does not exceed the manufacturer's declared value by more than 4 per cent, then the value declared by the manufacturer is taken as the type approval value.

5.5.3. If the average still exceeds the declared value by more than 4 per cent, a final test is run on the same vehicle. The average of the three test results is taken as the type approval value.

5.5.4. The electric range value adopted as the type approval value shall be the value declared by the manufacturer if this is no more than the value measured by the Technical Service. The declared value may be lower than the measured value without any limitations.

5.5.5. If the declared range value exceeds the value measured by the Technical Service, then another test is run on the same vehicle. When the manufacturer declared value does not exceed the average of the two test results, then the value declared by the manufacturer is taken as the type approval value.

5.5.6. If the declared value still exceeds the average measured value a final test is run on the same vehicle. The average of the three results is taken as the type approval value.

5.5.7. The electric range determined according to paragraphs 5.5.4. to 5.5.6. above is the only one which may be included in sales promotional material. This value must also be used for the calculations in Annex 8 to this Regulation, paragraphs 3.4.2.1. and 3.4.4.1.

6. Modification and extension of approval of the approved type

6.1. Every modification of the approved type shall be notified to the Type Approval Authority which approved the type. The Authority may then either:

6.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect on the values of CO_2 and fuel consumption or electric energy consumption and that, in this case, the original approval will be valid for the modified vehicle type; or

6.1.2. Require a further test report from the Technical Service responsible for conducting the tests according to conditions in paragraph 7. below.

6.2. Confirmation or extension of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3. of this Regulation to the Parties to the 1958 Agreement applying this Regulation.

6.3. The Type Approval Authority which grants the extension of the approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 4 to this Regulation.

7. Conditions of extension of the type approval for vehicle type

7.1. Vehicles powered by an internal combustion engine only, except vehicles equipped with a periodically regenerating emission control system

The type approval can be extended to vehicles from the same type or from a different type differing with regard to the following characteristics of Annex 4 to this Regulation if the CO_2 emissions measured by the Technical Service do not exceed the type approved value by more than 4 per cent for vehicles of category M_1 and 6 per cent for vehicles of category N_1:

7.1.1. Reference mass.

7.1.2. Maximum authorized mass.

7.1.3. Type of bodywork:

(a) For M_1: saloon, hatchback, station wagon, coupé, convertible, multipurpose vehicle[4];

(b) For N_1: lorry, van.

7.1.4. Overall gear ratios.

7.1.5. Engine equipment and accessories.

7.2. Vehicles powered by an internal combustion engine only and equipped with a periodically regenerating emission control system

The type approval can be extended to vehicles from the same type or from a different type, differing with regard to the characteristics of Annex 4, given in paragraphs 7.1.1. to 7.1.5. above, but not exceeding the family characteristics of Annex 10 to this Regulation, if the CO_2 emissions measured by the Technical Service do not exceed the type approved value by more than 4 per cent for vehicles of category M_1 and 6 per cent for vehicles of category N_1, and where the same K_i factor is applicable.

The type approval can be extended also to vehicles from the same type, but with a different K_i factor, if the corrected CO_2 value measured by the Technical Service does not exceed the type approved value by more than 4 per cent for vehicles of category M_1 and 6 per cent for vehicles of category N_1.

7.3. Vehicles powered by an electric power train only

Extensions may be granted after agreement with the Technical Service responsible for conducting the tests.

7.4. Vehicles powered by a hybrid electric power train

The type approval can be extended to vehicles from the same type or from a different type differing with regard to the following characteristics of Annex 4 to this Regulation if the CO_2 emissions and the electric energy consumption measured by the Technical Service do not exceed the type approved value by more than 4 per cent for vehicles of category M_1 and 6 per cent for vehicles of category N_1:

7.4.1. Reference mass.

7.4.2. Maximum authorized mass.

7.4.3. Type of bodywork:

(a) For M_1: saloon, hatchback, station wagon, coupé, convertible, multipurpose vehicle[4]

(b) For N_1: lorry, van.

7.4.4. With respect to a change in any other characteristic extensions may be granted after agreement with the Technical Service responsible for conducting the tests.

[4] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.2, para. 2.

7.5. Extension of approval of vehicles of category N_1 within a family, if powered by an internal combustion engine only or by a hybrid electric power train

7.5.1. For vehicles of category N_1 that are approved as members of a vehicle family using the procedure in paragraph 7.6.2. below, the type approval can be extended to vehicles from within the same family only if the Technical Service estimates that the fuel consumption of the new vehicle does not exceed the fuel consumption of the vehicle on which the family's fuel consumption is based.

Approvals may also be extended to vehicles which:

(a) Are up to 110 kg heavier than the family member tested, provided that they are within 220 kg of the lightest member of the family,

(b) Have a lower overall transmission ratio than the family member tested due solely to a change in tyre sizes, and

(c) Conform to the family in all other respects.

7.5.2. For vehicles of category N_1 that are approved as members of a vehicle family using the procedure in paragraph 7.6.3. below, the type approval can be extended to vehicles from within the same family without additional testing only if the Technical Service estimates that the fuel consumption of the new vehicle falls within the limits made up of those two vehicles in the family that have the lowest and the highest fuel consumption, respectively.

7.6. Approval of vehicles of category N_1 within a family, if powered by an internal combustion engine only or by a hybrid electric power train

Vehicles of category N_1 can be approved within a family as defined in paragraph 7.6.1. below using one of the two alternative methods described in paragraphs 7.6.2. and 7.6.3. below.

7.6.1. N_1 vehicles may be grouped together into a family for the purposes of this Regulation if the following parameters are identical or within the specified limits:

7.6.1.1. Identical parameters are:

(a) Manufacturer and type as defined in Annex 4 to this Regulation, item 2.;

(b) Engine capacity;

(c) Emission control system type;

(d) Fuel system type as defined in Annex 4 to this Regulation, item 6.7.2.

7.6.1.2. The following parameters have to be within the following limits:

(a) Transmission overall ratios (no more than 8 per cent higher than the lowest) as defined in Annex 4 to this Regulation, item 6.10.3.;

(b) Reference mass (no more than 220 kg lighter than the heaviest),

(c) Frontal area (no more than 15 per cent smaller than the largest);

(d) Engine power (no more than 10 per cent less than the highest value).

7.6.2. A vehicle family, as defined in paragraph 7.6.1. above, can be approved with CO_2 emission and fuel consumption data that are common to all members of the family. The Technical Service must select for testing the member of the family which the service considers to have the highest CO_2 emission. The measurements are performed as described in paragraph 5. above and Annex 6 to this Regulation, and the results according to the method described in paragraph 5.5. above are used as type-approval values that are common to all members of the family.

7.6.3. Vehicles that are grouped in a family as defined in paragraph 7.6.1. above can be approved with individual CO_2 emission and fuel consumption data for each of the family members. The Technical Service selects for testing the two vehicles, which the service considers to have the highest and the lowest CO_2 emissions respectively. The measurements are performed as described in paragraph 5. above and Annex 6 to this Regulation. If the manufacturer's data for these two vehicles falls within the tolerance limits described in paragraph 5.5. above, the CO_2 emissions declared by the manufacturer for all members of the vehicle family can be used as type approval values. If the manufacturer's data do not fall within the tolerance limits, the results according to the method described in paragraph 5.5. above are used as type approval values and the Technical Service shall select an appropriate number of other family members for additional tests.

8. Special provisions

In the future, vehicles with special energy efficient technologies may be offered which could be submitted to complementary testing programmes. These would be specified at a later stage which can be claimed by the manufacturer in order to demonstrate the advantages of the solution.

9. Conformity of production

9.1. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved vehicle.

9.2. So as to verify that the conditions set out in paragraph 9.1. above are complied with, appropriate production checks shall be carried out.

9.3. Vehicles powered by an internal combustion engine only:

9.3.1. As a general rule, measures to ensure the conformity of production with regard to CO_2 emissions from vehicles are checked on the basis of the description in the type approval certificate conforming to the model in Annex 4 to this Regulation.

The control of production conformity is based on an assessment made by the Type Approval Authority of the manufacturer's auditing procedure in order to ensure conformity of the vehicle type with respect to the emission of CO_2.

If the Type Approval Authority is not satisfied with the standard of the manufacturer's auditing procedure, they may require that verification tests be carried out on vehicles in production.

9.3.1.1. If a measurement of the emissions of CO_2 must be carried out on a vehicle type that has had one or several extensions, the tests will be carried out on the vehicle(s) available at the time of the test (vehicle(s) described in the first document or in subsequent extensions).

9.3.1.1.1. Conformity of the vehicle for the CO_2 test.

9.3.1.1.1.1. Three vehicles are randomly taken in the series and are tested according to the procedure as described in Annex 6 to this Regulation.

9.3.1.1.1.2. If the Type Approval Authority is satisfied with the production standard deviation given by the manufacturer, the tests are carried out according to paragraph 9.3.2. below.

If the Type Approval Authority is not satisfied with the production standard deviation given by the manufacturer, the tests are carried out according to paragraph 9.3.3. below.

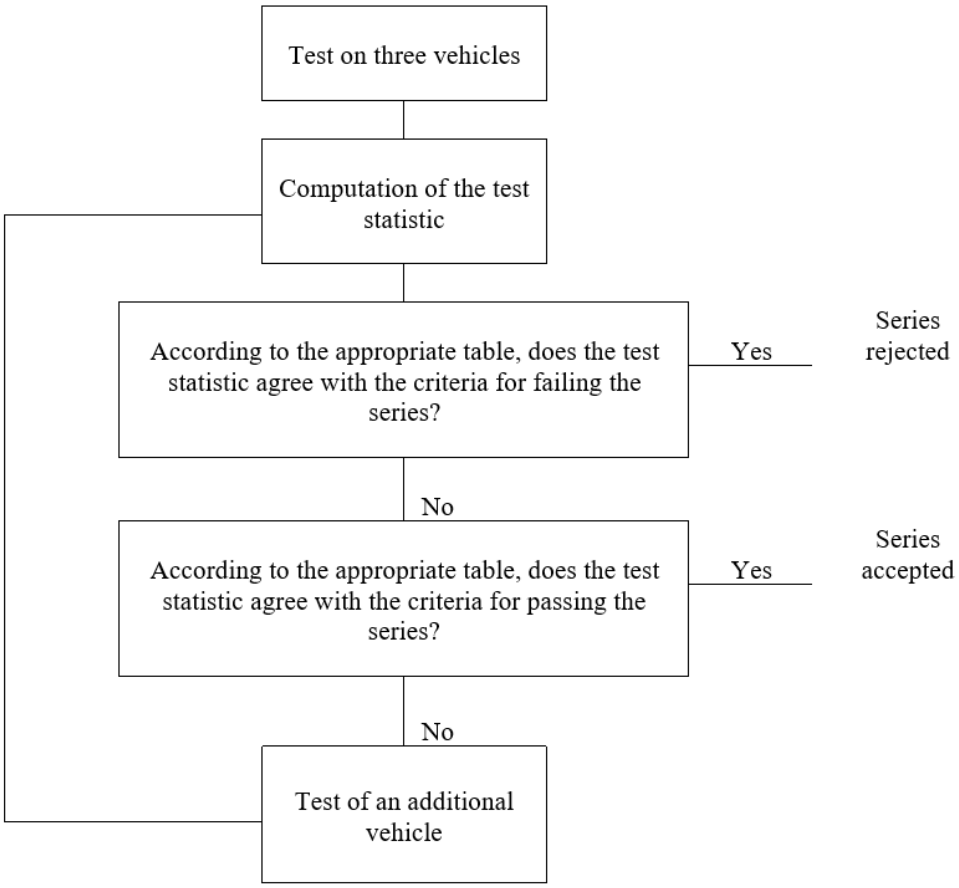
9.3.1.1.1.3. The production of a series is regarded as conforming or non-conforming, on the basis of tests on the three sampled vehicles, once a pass or fail decision is reached for CO_2, according to the test criteria applied in the appropriate table.

If no pass or fail decision is reached for CO_2, a test is carried out on an additional vehicle (see Figure 1).

9.3.1.1.1.4. In the case of periodically regenerating systems as defined in paragraph 2.16. above, the results shall be multiplied by the factor K_i obtained by the procedure specified in Annex 10 to this Regulation at the time when type approval was granted.

At the request of the manufacturer, testing may be carried out immediately after a regeneration has been completed.

Figure 1



9.3.1.1.2. Notwithstanding the requirements of Annex 6 to this Regulation, the tests will be carried out on vehicles which have not travelled any distance.

9.3.1.1.2.1. However, at the request of the manufacturer, the tests will be carried out on vehicles which have been run-in a maximum of 15,000 km.

In this case, the running-in procedure will be conducted by the manufacturer who shall undertake not to make any adjustments to those vehicles.

9.3.1.1.2.2. If the manufacturer asks to conduct a running-in procedure ("x" km, where $x \leq 15{,}000$ km), it may be carried out as follows:

The emissions of CO_2 will be measured at zero and at "x" km on the first tested vehicle (which can be the type approval vehicle);

The evolution coefficient (EC) of the emissions between zero and "x" km will be calculated as follows:

$$EC = \frac{Emissions\ at\ x\ km}{Emissions\ at\ zero\ km}$$

The value of EC may be less than 1.

The following vehicles will not be subjected to the running-in procedure, but their zero km emissions will be modified by the evolution coefficient, EC.

In this case, the values to be taken will be:

The value at "x" km for the first vehicle;

The values at zero km multiplied by the evolution coefficient for the following vehicles.

9.3.1.1.2.3. As an alternative to this procedure, the car manufacturer can use a fixed evolution coefficient, EC, of 0.92 and multiply all values of CO_2 measured at zero km by this factor.

9.3.1.1.2.4. The reference fuels described in Annexes 10 and 10a to Regulation No. 83 shall be used for this test.

9.3.2. Conformity of production when manufacturer's statistical data is available.

9.3.2.1. The following paragraphs describe the procedure to be used to verify the CO_2 conformity of production requirements when the manufacturer's production standard deviation is satisfactory.

9.3.2.2. With a minimum sample size of three the sampling procedure is set so that the probability of a lot passing a test with 40 per cent of the production defective is 0.95 (producer's risk = 5 per cent) while the probability of a lot being accepted with 65 per cent of the production defective is 0.1 (consumer's risk = 10 per cent).

9.3.2.3. The following procedure is used (see Figure 1):

Let L be the natural logarithm of the CO_2 type approval value:

x_I = the natural logarithm of the measurement for the i-th vehicle of the sample;

s = an estimate of the production standard deviation (after taking the natural logarithm of the measurements);

n = the current sample number.

9.3.2.4. Compute for the sample, the test statistic quantifying the sum of the standardized deviations to the limit and defined as:

$$\frac{1}{s}\sum_{i=1}^{n}(L - x_i)$$

9.3.2.5. Then:

9.3.2.5.1. If the test statistic is greater than the pass decision number for the sample given in Table 1, a pass decision is reached;

9.3.2.5.2. If the test statistic is less than the fail decision number for the sample size given in Table 1, a fail decision is reached;

9.3.2.5.3. Otherwise, an additional vehicle is tested according to Annex 6 to this Regulation and the procedure is applied to the sample with one unit more.

Table 1

Sample Size *(cumulative number of vehicles tested)*	*Pass decision No.*	*Fail decision No.*
(a)	(b)	(c)

Sample Size (cumulative number of vehicles tested)	*Pass decision No.*	*Fail decision No.*
3	3.327	- 4.724
4	3.261	- 4.790
5	3.195	- 4.856
6	3.129	- 4.922
7	3.063	- 4.988
8	2.997	- 5.054
9	2.931	- 5.120
10	2.865	- 5.185
11	2.799	- 5.251
12	2.733	- 5.317
13	2.667	- 5.383
14	2.601	- 5.449
15	2.535	- 5.515
16	2.469	- 5.581
17	2.403	- 5.647
18	2.337	- 5.713
19	2.271	- 5.779
20	2.205	- 5.845
21	2.139	- 5.911
22	2.073	- 5.977
23	2.007	- 6.043
24	1.941	- 6.109
25	1.875	- 6.175
26	1.809	- 6.241
27	1.743	- 6.307
28	1.677	- 6.373
29	1.611	- 6.439
30	1.545	- 6.505
31	1.479	- 6.571
32	- 2.112	- 2.112

9.3.3. Conformity of production when manufacturer's statistical data is unsatisfactory or unavailable.

9.3.3.1. The following sections describe the procedure to be used to verify the CO_2 conformity of production requirements when the manufacturer's evidence of production standard deviation is either unsatisfactory or unavailable.

9.3.3.2. With a minimum sample size of three the sampling procedure is set so that the probability of a lot passing a test with 40 per cent of the production defective is 0.95 (producer's risk = 5 per cent) while the probability of a lot being accepted with 65 per cent of the production defective is 0.1 (consumer's risk = 10 per cent).

9.3.3.3. The measurement of CO_2 is considered to be log normally distributed and should first be transformed by taking the natural logarithms. Let m_o and m

denote the minimum and maximum sample sizes respectively ($m_o = 3$ and $m = 32$) and let n denote the current sample number.

9.3.3.4. If the natural logarithms of the measurements in the series are $x_1, x_2, ..., x_j$ and L is the natural logarithm of the CO_2 type approval value, then define:

$$d_j = x_j - L$$

$$\bar{d}_n = \frac{1}{n}\sum_{j=1}^{n} d_j$$

$$v^2_n = \frac{1}{n}\sum_{j=1}^{n} (d_j - \bar{d}_n)^2$$

9.3.3.5. Table 2 shows values of the pass (A_n) and fail (B_n) decision numbers against current sample number. The test statistic is the ratio $\bar{d}_n / v_n$ and shall be used to determine whether the series has passed or failed as follows:

for $m_o \leq n \leq m$:

9.3.3.5.1. Pass the series if $\bar{d}_n / v_n \leq A_n$;

9.3.3.5.2. Fail the series if $\bar{d}_n / v_n \geq B_n$;

9.3.3.5.3. Take another measurement if $A_n < \bar{d}_n / v_n < B_n$.

Table 2

Sample Size *(cumulative number of vehicles tested)* *n*	*Pass decision No.* A_n	*Fail decision No.* B_n
(a)	(b)	(c)
3	-0.80380	16.64743
4	-0.76339	7.68627
5	-0.72982	4.67136
6	-0.69962	3.25573
7	-0.67129	2.45431
8	-0.64406	1.94369
9	-0.61750	1.59105
10	-0.59135	1.33295
11	-0.56542	1.13566
12	-0.53960	0.97970
13	-0.51379	0.85307
14	-0.48791	0.74801
15	-0.46191	0.65928
16	-0.43573	0.58321
17	-0.40933	0.51718
18	-0.38266	0.45922
19	-0.35570	0.40788
20	-0.32840	0.36203
21	-0.30072	0.32078
22	-0.27263	0.28343
23	-0.24410	0.24943
24	-0.21509	0.21831
25	-0.18557	0.18970
26	-0.15550	0.16328
27	-0.12483	0.13880
28	-0.09354	0.11603
29	-0.06159	0.09480
30	-0.02892	0.07493
31	0.00449	0.05629
32	0.03876	0.03876

9.3.3.6. Remarks

The following recursive formulae are useful for computing successive values of the test statistic:

$$\bar{d}_n = \left(1 - \frac{1}{n}\right)\bar{d}_{n-1} + \frac{1}{n}d_n$$

$$v_n^2 = \left(1 - \frac{1}{n}\right)v_{n-1}^2 + \frac{(\bar{d}_n - d_n)^2}{n-1}$$

$(n = 2, 3, ...;\ \bar{d}_1 = d_1;\ v_1 = 0)$

9.4. Vehicles powered by an electric power train only:

As a general rule, measures to ensure the conformity of production with regard to electric energy consumption is checked on the basis of the description in the type approval certificate set out in Annex 4 to this Regulation.

9.4.1. The holder of the approval shall, in particular:

9.4.1.1. Ensure the existence of procedures for the effective control of production quality;

9.4.1.2. Have access to the equipment necessary for checking conformity with each approved type;

9.4.1.3. Ensure that the data concerning the test result are recorded and that the annexed documents are available during a period to be agreed with the Type Approval Authority;

9.4.1.4. Analyse the results of each type of test so as to monitor and ensure the consistency of the characteristics of the product, taking into account the variations admissible in industrial manufacture;

9.4.1.5. Make sure that for each type of vehicle, the electric energy consumption testing prescribed in Annex 7 to this Regulation is carried out; notwithstanding the requirements of paragraph 5.1.1.6. of Annex 7 to this Regulation, at the request of the manufacturer, the tests will be carried out on vehicles which have not travelled any distance; as an alternative at the choice of the manufacturer, the electric energy consumption may be confirmed by testing according to the procedure that is described in paragraph 9.4.3. below.

9.4.1.6. Make sure that any collections of samples or test pieces demonstrating non-conformity with the type test under consideration is followed by a subsequent sampling and a further test. All necessary steps shall be taken to re-establish the conformity of production.

9.4.2. The competent authorities issuing the approval may verify at any time the methods applied in each production unit.

9.4.2.1. In every inspection, the records of tests and production monitoring shall be communicated to the visiting inspector.

9.4.2.2. The inspector may select at random the samples to be tested in the manufacturer's laboratory. The minimum number of samples may be determined on the basis of the results of the manufacturer's own checks.

9.4.2.3. When the quality standard does not seem satisfactory or when it seems necessary to verify the validity of the tests conducted under paragraph 9.4.2.2. above, the inspector shall collect samples to be sent to the Technical Service which carried out the approval tests.

9.4.2.4. The Type Approval Authorities may carry out all the tests prescribed in this Regulation.

9.4.3. Alternative at the choice of the manufacturer for electric energy consumption verification for conformity of production

9.4.3.1. During the conformity of production procedure, the break-off criterion for the Type 1 test procedure according to paragraph 5.2.3.1. to Annex 7 to this Regulation (consecutive cycle procedure) and paragraph 5.2.3.2. to Annex 7 to this Regulation (Shortened Test Procedure) shall be replaced with the following:

The break-off criterion for the conformity of production procedure shall be reached with having finished the first two NEDC test cycles according to paragraph 2. to Annex 7 to this Regulation.

9.4.3.2. During these first two NEDC test cycles, the DC energy from the REESS(s) shall be measured according to the method described in Appendix 3 to Annex 7 to this Regulation and divided by the driven distance in these two NEDC test cycles.

9.4.3.3. The value determined according to paragraph 9.4.3.2. shall be compared to the value determined according to paragraph 9.4.3.5.

9.4.3.4. Conformity for electric energy consumption shall be checked using the statistical procedures described in Section 9.3. For the purposes of this conformity check, the term CO_2 shall be replaced by electric energy consumption.

9.4.3.5. Electric energy consumption for vehicles powered by an electric power train only

The following value shall be declared and used for verifying the conformity of production with respect to the electric consumption:

$$EC_{DC,COP} = EC_{DC,first\ two\ NEDC} \times AF_{EC}$$

where:

$EC_{DC,COP}$ is the value for electric energy consumption that has to be confirmed during the conformity of production test procedure within the first two NEDC test cycles, in Wh/km;

$EC_{DC,first\ two\ NEDC}$ is the electric energy consumption of the first two NEDC test cycles calculated according to paragraph 5.2.5.1. to Annex 7 for type approval purposes, in Wh/km;

AF_{EC} is the adjustment factor that adjusts the electric energy consumption that has to be confirmed in COP based on the difference between calculated and declared electric energy consumption for type approval purposes.

and:

$$AF_{EC} = \frac{C_{dec}}{C}$$

where:

C_{dec} is the declared electric energy consumption according to Section 5.5. in Wh/km;

C is the electric energy consumption according to paragraph 5.2.5.3. to Annex 7, in Wh/km.

9.5. Vehicles powered by a hybrid electric power train

As a general rule, measures to ensure the conformity of production with regard to CO_2 emissions and electric energy consumption from hybrid electric vehicles is checked on the basis of the description in the type approval certificate conforming to the model in Annex 4 to this Regulation.

The control of production conformity is based on an assessment made by the Type Approval Authority of the manufacturer's auditing procedure in order to ensure conformity of the vehicle type with respect to the emission of CO_2 and the electric energy consumption.

If the Type Approval Authority is not satisfied with the standard of the manufacturer's auditing procedure, they may require that verification tests be carried out on vehicles in production.

Conformity for CO_2 emissions is checked using the statistical procedures described in paragraphs 9.3.1. to 9.3.3. above. Vehicles are tested according to the procedure described in Annex 8 to this Regulation.

9.6. Actions to be taken in case of non-conformity of production

If, during inspections, non-conformity is observed, the Type Approval Authority shall ensure that all necessary steps are taken to re-establish conformity of production as soon as possible.

10. Penalties for non-conformity of production

10.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 9.1. of this Regulation are not complied with.

10.2. If a Contracting Party to the 1958 Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 4 to this Regulation.

11. Production definitively discontinued

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the Type Approval Authority which granted the approval. Upon receiving the relevant communication, that Authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 4 to this Regulation.

12. Names and addresses of Technical Services responsible for conducting approval tests and of Type Approval Authorities

The Parties to the 1958 Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and the Type

Approval Authorities which grant approval and to which, forms certifying approval or refusal or extension or withdrawal of approval, issued in other countries, are to be sent.

13. Transitional provisions

13.1. As from the official date of entry into force of Supplement 4 to the 01 series of amendments to Regulation No. 101, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals under this Regulation as amended by Supplement 4 to the 01 series of amendments.

13.2. Contracting Parties applying this Regulation shall not refuse to grant extensions of type approvals for vehicle types which have been issued according to this Regulation in any of its versions.

13.3. Contracting Parties applying this Regulation may continue to grant type approvals to those types of vehicles which comply with the requirements of this Regulation in any of its versions, provided that the vehicles are approved or are intended to be approved to any series of amendments preceding the 07 series of amendments to Regulation No. 83.

13.4. After the entry into force of Supplement 4 to the 01 series of amendments to this Regulation, Contracting Parties applying this Regulation shall not be obliged to accept, for the purpose of national or regional type approval, a vehicle type approved to this Regulation in any of its previous versions, unless they accept vehicles approved to any series of amendments preceding the 07 series of amendments to Regulation No. 83.

13.5 As from the official date of entry into force of Supplement 7 to the 01 series of amendments to UN Regulation No. 101, and by way of derogation to the obligations of Contracting Parties during the transitional period set out in paragraphs 13.1. to 13.4. above, the Contracting Parties applying this Regulation and also applying in their national/regional territory the provisions on the Worldwide Harmonized Light Vehicle Test Procedure (WLTP) set out in UN Global Technical Regulation No. 15 may no longer accept type approvals granted on the basis of this Regulation as an alternative to compliance with their national/regional legislation.

13.6. Until 1 September 2024, Contracting Parties applying this Regulation may continue to grant extensions of type approvals according to the 01 series of amendments to this Regulation, based on the test procedures for the discharge of electrical energy/power storage device of the vehicle described in paragraph 4.2.2.1. to Annex 8 of this Regulation, without taking into account the provisions of Supplement 12.

Annex 1

Essential characteristics of the vehicle powered by an internal combustion engine only and information concerning the conduct of tests

The following information, when applicable, shall be supplied in triplicate and shall include a summary.

If there are drawings, they shall be to an appropriate scale and show sufficient detail. They shall be presented in A4 format or folded to that format. In the case of microprocessor controlled functions, appropriate operating information shall be supplied.

1.	General
1.1.	Make (name of manufacturer): .....
1.2.	Type and commercial description (mention any variants): .....
1.3.	Means of identification of type, if marked on the vehicle:.....
1.3.1.	Location of that mark:.....
1.4.	Category of vehicle:.....
1.5.	Name and address of manufacturer:.....
1.6.	Name and address of manufacturer's authorized representative where appropriate:.....
1.7.	Name(s) and address(es) of assembly plant(s): .....
2.	General construction characteristics of the vehicle
2.1.	Photographs and/or drawings of a representative vehicle: .....
2.2.	Powered axles (number, position, interconnection): .....
3.	Masses (kilograms) (refer to drawing where applicable)
3.1.	Mass of the vehicle with bodywork in running order, or mass of the chassis with cab if the manufacturer does not fit the bodywork (including coolant, oils, fuel, tools, spare wheel and driver): .....
3.2.	Technically permissible maximum laden mass as stated by the manufacturer:.....
4.	Description of power train and power train components
4.1.	Internal combustion engine
4.1.1.	Engine manufacturer:.....
4.1.2.	Manufacturer's engine code (as marked on the engine, or other means of identification):.....
4.1.2.1.	Working principle: positive-ignition/compression-ignition, four-stroke/two-stroke[1]
4.1.2.2.	Number, arrangement and firing order of cylinders:
4.1.2.2.1.	Bore[2]: ..... mm

4.1.2.2.2.	Stroke[2]:..... mm
4.1.2.3.	Engine capacity[3]:..... cm^3
4.1.2.4.	Volumetric compression ratio[4]:.....
4.1.2.5.	Drawings of combustion chamber and piston crown: .....
4.1.2.6.	Idle speed[4]:.....
4.1.2.7.	Carbon monoxide content by volume in the exhaust gas with the engine idling: …….. per cent (according to the manufacturer's specifications)[4] .....
4.1.2.8.	Maximum net power: ..... kW at min^{-1}
4.1.3.	Fuel: petrol / unleaded petrol / diesel oil / LPG / NG[1]
4.1.3.1.	Research octane number (RON): .....
4.1.4.	Fuel feed
4.1.4.1.	By carburettor(s): Yes/No[1]
4.1.4.1.1.	Make(s): .....
4.1.4.1.2.	Type(s): .....
4.1.4.1.3.	Number fitted: .....
4.1.4.1.4.	Adjustments[4]:
4.1.4.1.4.1.	Jets: .....
4.1.4.1.4.2.	Venturis:.....
4.1.4.1.4.3.	Float-chamber level: .....
4.1.4.1.4.4.	Mass of float: .....
4.1.4.1.4.5.	Float needle:.....
4.1.4.1.5.	Cold start system: manual/automatic[1]
4.1.4.1.5.1.	Operating principle: .....
4.1.4.1.5.2.	Operating limits/settings[1,4]:.....
4.1.4.2.	By fuel injection (compression-ignition only): Yes/No[1]
4.1.4.2.1.	System description:.....
4.1.4.2.2.	Working principle: direct-injection/pre-chamber/swirl chamber[1]
4.1.4.2.3.	Injection pump
4.1.4.2.3.1.	Make(s): .....
4.1.4.2.3.2.	Type(s):.....
4.1.4.2.3.3.	Maximum fuel delivery[1,4]:…….. mm^3 / stroke or cycle at a pump speed of [1,4]:…….. min^{-1} or characteristic diagram:.....
4.1.4.2.3.4.	Injection timing[4]:.....
4.1.4.2.3.5.	Injection advance curve[4]: .....
4.1.4.2.3.6.	Calibration procedure: test bench/engine[1].....
4.1.4.2.4.	Governor

4.1.4.2.4.1. Type: .....

4.1.4.2.4.2. Cut-off point:

4.1.4.2.4.2.1. Cut-off point under load: ..... min^{-1}

4.1.4.2.4.2.2. Cut-off point without load: ..... min^{-1}

4.1.4.2.4.3. Idling speed: ..... min^{-1}

4.1.4.2.5. Injector(s):

4.1.4.2.5.1. Make(s): .....

4.1.4.2.5.2. Type(s): .....

4.1.4.2.5.3. Opening pressure[4]:…….. kPa or characteristic diagram: .....

4.1.4.2.6. Cold start system

4.1.4.2.6.1. Make(s): .....

4.1.4.2.6.2. Type(s): .....

4.1.4.2.6.3. Description: .....

4.1.4.2.7. Auxiliary starting aid:

4.1.4.2.7.1. Make(s): .....

4.1.4.2.7.2. Type(s): .....

4.1.4.2.7.3. Description: .....

4.1.4.3. By fuel injection (positive-ignition only): Yes/No[1]

4.1.4.3.1. System description:

4.1.4.3.2. Working principle[1]: intake manifold (single/multi-point) / direct injection / other (specify)

Control unit – type (or No.): .....
Fuel regulator – type: .....
Air-flow sensor - type: .....
Fuel distributor - type: .....
Pressure regulator - type: .....
Micro-switch – type: .....
Idle adjusting screw – type: .....
Throttle housing - type: .....
Water temperature sensor – type: .....
Air temperature sensor – type: .....
Air temperature switch – type: .....

} information to be given in the case of continuous injection; in the case of other systems, equivalent details

Electromagnetic interference protection .....

Description and/or drawing: .....

4.1.4.3.3. Make(s): .....

4.1.4.3.4. Type(s): .....

4.1.4.3.5.	Injectors: Opening pressure[4]: .....kPa or characteristic diagram[4]:.....
	.....
4.1.4.3.6.	Injection timing:.....
4.1.4.3.7.	Cold start system:.....
4.1.4.3.7.1.	Operating principle(s): .....
4.1.4.3.7.2.	Operating limits/settings[1,4]:.....
4.1.4.4.	Feed pump
4.1.4.4.1.	Pressure[4]: ..... kPa or characteristic diagram: .....
4.1.4.5.	By LPG fuelling system: Yes/No[1]
4.1.4.5.1.	Approval number according to Regulation No. 67 and documentation: ...
	.....
4.1.4.5.2.	Electronic Engine Management Control Unit for LPG-fuelling:
4.1.4.5.2.1.	Make(s): .....
4.1.4.5.2.2.	Type: .....
4.1.4.5.2.3.	Emission related adjustment possibilities: .....
4.1.4.5.3.	Further documentation:
4.1.4.5.3.1.	Description of the safeguarding of the catalyst at switch-over from petrol to LPG or back:.....
4.1.4.5.3.2.	System lay-out (electrical connections, vacuum connections compensation hoses, etc.):.....
4.1.4.5.3.3.	Drawing of the symbol:.....
4.1.4.6.	By NG fuelling system: Yes/No[1]
4.1.4.6.1.	Approval number according to Regulation No. 67: .....
4.1.4.6.2.	Electronic Engine Management Control Unit for NG-fuelling:
4.1.4.6.2.1.	Make(s): .....
4.1.4.6.2.2.	Type: .....
4.1.4.6.2.3.	Emission related adjustment possibilities: .....
4.1.4.6.3.	Further documentation:
4.1.4.6.3.1.	Description of the safeguarding of the catalyst at switch-over from petrol to NG or back:.....
4.1.4.6.3.2.	System lay-out (electrical connections, vacuum connections compensation hoses, etc.):.....
4.1.4.6.3.3.	Drawing of the symbol:.....
4.1.5.	Ignition
4.1.5.1.	Make(s): .....
4.1.5.2.	Type(s):.....
4.1.5.3.	Working principle: .....

4.1.5.4.	Ignition advance curve[4]:.....
4.1.5.5.	Static ignition timing[4]:.....……. degrees before TDC
4.1.5.6.	Contact-point gap[4]: .....
4.1.5.7.	Dwell-angle[4]: .....
4.1.5.8.	Spark plugs
4.1.5.8.1.	Make: .....
4.1.5.8.2.	Type: .....
4.1.5.8.3.	Spark plug gap setting: ..... mm
4.1.5.9.	Ignition coil
4.1.5.9.1.	Make: .....
4.1.5.9.2.	Type: .....
4.1.5.10.	Ignition condenser
4.1.5.10.1.	Make: .....
4.1.5.10.2.	Type: .....
4.1.6.	Cooling system: liquid/air[1]
4.1.7.	Intake system:
4.1.7.1.	Pressure charger: Yes/No[1]
4.1.7.1.1.	Make(s): .....
4.1.7.1.2.	Type(s): .....
4.1.7.1.3.	Description of the system (maximum charge pressure: ……kPa, waste-gate)
4.1.7.2.	Inter-cooler: Yes/No[1]
4.1.7.3.	Description and drawings of inlet pipes and their accessories (plenum chamber, heating device, additional air intakes, etc.): .....
4.1.7.3.1.	Intake manifold description (drawings and/or photographs):.....
4.1.7.3.2.	Air filter, drawings: ……, or
4.1.7.3.2.1.	Make(s): .....
4.1.7.3.2.2.	Type(s): .....
4.1.7.3.3.	Intake silencer, drawings: ……..., or
4.1.7.3.3.1.	Make(s): .....
4.1.7.3.3.2.	Type(s): .....
4.1.8.	Exhaust system
4.1.8.1.	Description and drawings of the exhaust system: .....
4.1.9.	Valve timing or equivalent data:
4.1.9.1.	Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to dead centres:.....
4.1.9.2.	Reference and/or setting ranges[1]: .....

4.1.10.	Lubricant used:
4.1.10.1.	Make: .....
4.1.10.2.	Type: .....
4.1.11.	Measures taken against air pollution:
4.1.11.1.	Device for recycling crankcase gases (description and drawings): .....
4.1.11.2.	Additional pollution control devices (if any, and if not covered by another heading:
4.1.11.2.1.	Catalytic converter: Yes/No[1]
4.1.11.2.1.1.	Number of catalytic converters and elements: .....
4.1.11.2.1.2.	Dimensions and shape of the catalytic converter(s) (volume, ...): .....
4.1.11.2.1.3.	Type of catalytic action: .....
4.1.11.2.1.4.	Total charge of precious metal: .....
4.1.11.2.1.5.	Relative concentration: .....
4.1.11.2.1.6.	Substrate (structure and material): .....
4.1.11.2.1.7.	Cell density: .....
4.1.11.2.1.8.	Type of casing for catalytic converter(s): .....
4.1.11.2.1.9.	Positioning of the catalytic converter(s) (place and reference distances in the exhaust system): .....
4.1.11.2.1.10.	Regeneration systems/method of exhaust after-treatment systems, description:
4.1.11.2.1.10.1.	The number of Type I operating cycles, or equivalent engine test bench cycles, between two cycles where regenerative phases occur under the conditions equivalent to Type I test (Distance "D" in Figure 10/1 in Annex 10 to this Regulation): .....
4.1.11.2.1.10.2.	Description of method employed to determine the number of cycles between two cycles where regenerative phases occur: .....
4.1.11.2.1.10.3.	Parameters to determine the level of loading required before regeneration occurs (i.e. temperature, pressure etc.): .....
4.1.11.2.1.10.4.	Description of method used to load system in the test procedure described in paragraph 3.1. of Annex 10 to this Regulation: .....
4.1.11.2.1.11.	Oxygen sensor: type
4.1.11.2.1.11.1.	Location of oxygen sensor: .....
4.1.11.2.1.11.2.	Control range of oxygen sensor: .....
4.1.11.2.2.	Air injection: Yes/No[1]
4.1.11.2.2.1.	Type (pulse air, air pump, ...): .....
4.1.11.2.3.	Exhaust gas recirculation (EGR): Yes/No[1]
4.1.11.2.3.1.	Characteristics (flow, ...): .....

	4.1.11.2.4.	Evaporative emission control system.
		Complete detailed description of the devices and their state of tune: .....
		Drawing of the evaporative control system: .....
		Drawing of the carbon canister: .....
		Drawing of the fuel tank with indication of capacity and material: .....
	4.1.11.2.5.	Particulate trap: Yes/No[1]
	4.1.11.2.5.1.	Dimensions and shape of the particulate trap (capacity):.....
	4.1.11.2.5.2.	Type of particulate trap and design:.....
	4.1.11.2.5.3.	Location of the particulate trap (reference distances in the exhaust system): .....
	4.1.11.2.5.4.	Regeneration system/method. Description and drawing:.....
	4.1.11.2.5.4.1.	The number of Type I operating cycles, or equivalent engine test bench cycle, between two cycles where regeneration phases occur under the conditions equivalent to Type I test (Distance "D" in Figure 10/1 in Annex 10 to this Regulation):.....
	4.1.11.2.5.4.2.	Description of method employed to determine the number of cycles between two cycles where regenerative phases occur:.....
	4.1.11.2.5.4.3.	Parameters to determine the level of loading required before regeneration occurs (i.e. temperature, pressure, etc.):.....
	4.1.11.2.5.4.4.	Description of method used to load system in the test procedure described in paragraph 3.1. of Annex 10 to this Regulation: .....
	4.1.11.2.6.	Other systems (description and working principle): .....
	4.2.	Power train control unit
	4.2.1.	Make: .....
	4.2.2.	Type: .....
	4.2.3.	Identification number: .....
4.3.	Transmission	
	4.3.1.	Clutch (type): .....
	4.3.1.1.	Maximum torque conversion: .....
	4.3.2.	Gearbox:.....
	4.3.2.1.	Type: .....
	4.3.2.2.	Location relative to the engine:.....
	4.3.2.3.	Method of control: .....

4.3.3. Gear ratios

	Gearbox ratios	*Final drive ratios*	*Total ratios*
Maximum for CVT (*)			
1			
2			
3			
4, 5, others			
Minimum for CVT (*)			
Reverse			

(*) CVT - Continuously variable transmission

5. Suspension

5.1. Tyres and wheels

5.1.1. Tyre/wheel combination(s) (for tyres indicate size designation, minimum load-capacity index, minimum speed category symbol; for wheels, indicate rim size(s) and off-set(s):

5.1.1.1. Axles

5.1.1.1.1. Axle 1:.....

5.1.1.1.2. Axle 2:.....

5.1.1.1.3. Axle 3:.....

5.1.1.1.4. Axle 4: etc.....

5.1.2. Upper and lower limit of rolling circumference:

5.1.2.1. Axles

5.1.2.1.1. Axle 1:.....

5.1.2.1.2. Axle 2:.....

5.1.2.1.3. Axle 3:.....

5.1.2.1.4. Axle 4: etc.....

5.1.3. Tyre pressure(s) as recommended by the manufacturer: ..... kPa

6. Bodywork

6.1. Seats:.....

6.1.1. Number of seats: .....

Strike out what does not apply.

[2] This value must be rounded to the nearest tenth of a millimetre.

[3] This value must be calculated with $\pi = 3.1416$ and rounded to the nearest cm^3.

[4] Specify the tolerance.

Annex 2

Essential characteristics of the vehicle powered by an electric power train only and information concerning the conduct of tests

The following information, when applicable, shall be supplied in triplicate and shall include a summary.

If there are drawings, they shall be to an appropriate scale and show sufficient detail. They shall be presented in A4 format or folded to that format. In the case of microprocessor controlled functions, appropriate operating information shall be supplied.

1.	General
1.1.	Make (name of manufacturer):.....
1.2.	Type and commercial description (mention any variants): .....
1.3.	Means of identification of type, if marked on the vehicle:.....
1.3.1.	Location of that mark:.....
1.4.	Category of vehicle: .....
1.5.	Name and address of manufacturer:.....
1.6.	Name and address of manufacturer's authorized representative where appropriate: .....
2.	General construction characteristics of the vehicle
2.1.	Photographs and/or drawings of a representative vehicle: .....
2.2.	Powered axles (number, position, interconnection): .....
3.	Masses (kilograms) (refer to drawing where applicable)
3.1.	Mass of the vehicle with bodywork in running order, or mass of the chassis with cab if the manufacturer does not fit the bodywork (including coolant, oils, fuel, tools, spare wheel and driver): .....
3.2.	Technically permissible maximum laden mass as stated by the manufacturer: .....
4.	Description of the power train and power train components
4.1.	General description of electric power train
4.1.1.	Make: .....
4.1.2.	Type: .....
4.1.3.	Use: Monomotor/multimotors[1] (number):.....
4.1.4.	Transmission arrangement: parallel/transaxial/others, to precise: ....
4.1.5.	Test voltage:..... V

4.1.6.	Motor nominal speed: ..... min^{-1}
4.1.7.	Motor maximum speed: ..... min^{-1}
	or by default:
	reducer outlet shaft/gear box speed (specify gear engaged): ..... min^{-1}
4.1.8.	Maximum power speed[2]:..... min^{-1}
4.1.9.	Maximum power:.....kW
4.1.10.	Maximum thirty minutes power:.....kW
4.1.11.	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}
4.2.	Traction battery
4.2.1.	Trade name and mark of the battery: .....
4.2.2.	Kind of electro-chemical couple: .....
4.2.3.	Nominal voltage:.....V
4.2.4.	Battery maximum thirty minutes power (constant power discharge): .....kW
4.2.5.	Battery performance in 2 h discharge (constant power or constant current)[1]:
4.2.5.1.	Battery energy:..... kWh
4.2.5.2.	Battery capacity: .....Ah in 2 h
4.2.5.3.	End of discharge voltage value: V
4.2.6.	Indication of the end of the discharge that leads to a compulsory stop of the vehicle[3]:.....
4.2.7.	Battery mass:..... kg
4.3.	Electric Motor
4.3.1.	Working principle:
4.3.1.1.	direct current/alternating current[1]/number of phases: .....
4.3.1.2.	Separate excitation/series/compound[1]
4.3.1.3.	Synchronous/asynchronous[1]
4.3.1.4.	Coiled rotor/with permanent magnets/with housing[1]
4.3.1.5.	Number of poles of the motor: .....
4.3.2.	Inertia mass: .....
4.4.	Power controller
4.4.1.	Make
4.4.2.	Type
4.4.3.	Control principle: vectorial/open loop/closed/other (to be specified)[1]:
4.4.4.	Maximum effective current supplied to the motor[2]:..... A
	during .....seconds

4.4.5.	Voltage range use: ……. V to V		
4.5.	Cooling system:		
	Motor: liquid/air[1]		
	Controller: liquid/air[1]		
4.5.1.	Liquid-cooling equipment characteristics:		
4.5.1.1.	Nature of the liquid ……circulating pumps: yes/no[1]		
4.5.1.2.	Characteristics or make(s) and type(s) of the pump:.....		
4.5.1.3.	Thermostat: setting:.....		
4.5.1.4.	Radiator: drawing(s) or make(s) and type(s):.....		
4.5.1.5.	Relief valve: pressure setting:		
4.5.1.6.	Fan: characteristics or make(s) and type(s):.....		
4.5.1.7.	Fan duct:.....		
4.5.2.	Air-cooling equipment characteristics		
4.5.2.1.	Blower: characteristics or make(s) and type(s):		
4.5.2.2.	Standard air ducting:		
4.5.2.3.	Temperature regulating system: yes/no[1]		
4.5.2.4.	Brief description:.....		
4.5.2.5.	Air filter: …… make(s): ……. type(s):		
4.5.3.	Temperatures admitted by the manufacturer		
			maximum temperature
4.5.3.1.	Motor outlet:		°C
4.5.3.2.	Controller inlet:.....		°C
4.5.3.3.	At motor reference point(s):.....		°C
4.5.3.4.	At controller reference point(s):.....		°C
4.6.	Insulating category:.....		
4.7.	International protection (IP)-code:.....		
4.8.	Lubrication system principle[1]:	Bearings:	friction/ball
		Lubricant:	grease/oil
		Seal:	yes/no
		Circulation:	with/without
4.9.	Description of the transmission		
4.9.1.	Drive wheels: front/rear/4x4[1]		
4.9.2.	Type of transmission: manual/automatic[1]		
4.9.3.	Number of gear ratios:		

DRAFT FOR CONSULTATION

4.9.3.1.

Gear	*Wheel speed*	*Gear ratio*	*Motor speed*
1			
2			
3			
4			
5			
Reverse			

minimum CVT (Continuous Variable Transmission): .....

maximum CVT: .....

4.9.4. Recommendations for changing the gears

1 → 2: ……	2 → 1: ……
2 → 3: ……	3 → 2: ……
3 → 4: ……	4 → 3: ……
4 → 5: ……	5 → 4: ……
overdrive in: ……	overdrive out: …….

5. Charger

5.1. Charger: on board/external[1]

In case of an external unit, define the charger (trademark, model): .....

.....

5.2. Description of the normal profile of charge: .....

5.3. Specification of mains:

5.3.1. Type of mains: single phase/three phase[1]

5.3.2. Voltage:.....

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

5.5. Theoretical duration of a complete charge:.....

6. Suspension

6.1. Tyres and wheels

6.1.1. Tyre/wheel combination(s) (for tyres indicate size designation, minimum load-capacity index, minimum speed category symbol; for wheels, indicate rim size(s) and off-set(s):

6.1.1.1. Axles

6.1.1.1.1. Axle 1:.....

6.1.1.1.2. Axle 2:.....

6.1.1.1.3. Axle 3:.....

6.1.1.1.4. Axle 4: etc. .....

6.1.2. Upper and lower limit of rolling circumference:

6.1.2.1. Axles

6.1.2.1.1. Axle 1:.....

6.1.2.1.2.	Axle 2:.....
6.1.2.1.3.	Axle 3:.....
6.1.2.1.4.	Axle 4: etc. .....
6.1.3.	Tyre pressure(s) as recommended by the manufacturer: ..... kPa
7.	Bodywork
7.1.	Seats: .....
7.1.1.	Number of seats: .....
8.	Inertia mass
8.1.	Equivalent inertia mass of complete front axle: .....
8.2.	Equivalent inertia mass of complete rear axle: .....

Strike out what does not apply
[2] Specify tolerances.
[3] If applicable.

Annex 3

Essential characteristics of the vehicle powered by a hybrid electric power train and information concerning the conduct of tests

The following information, when applicable, shall be supplied in triplicate and shall include a summary.

If there are drawings, they shall be to an appropriate scale and show sufficient detail. They shall be presented in A4 format or folded to that format. In the case of microprocessor controlled functions, appropriate operating information shall be supplied.

1.	General
1.1.	Make (name of manufacturer):.....
1.2.	Type and commercial description (mention any variants): .....
1.3.	Means of identification of type, if marked on the vehicle:.....
1.3.1.	Location of that mark:.....
1.4.	Category of vehicle: .....
1.5.	Name and address of manufacturer:.....
1.6.	Name and address of manufacturer's authorized representative where appropriate: .....
2.	General construction characteristics of the vehicle
2.1.	Photographs and/or drawings of a representative vehicle: .....
2.2.	Powered axles (number, position, interconnection): .....
3.	Masses (kilograms) (refer to drawing where applicable)
3.1.	Mass of the vehicle with bodywork in running order, or mass of the chassis with cab if the manufacturer does not fit the bodywork (including coolant, oils, fuel, tools, spare wheel and driver): .....
3.2.	Technically permissible maximum laden mass as stated by the manufacturer: .....
4.	Description of power train and power train components
4.1.	Description of the hybrid electric vehicle
4.1.1.	Category of hybrid electric vehicle: Off-Vehicle Charging/Not Off Vehicle charging[1]
4.1.2.	Operating mode switch: with/without[1]
4.1.2.1.	Selectable modes:
4.1.2.1.1.	Pure electric: Yes/No[1]
4.1.2.1.2.	Pure fuel consuming: Yes/No[1]
4.1.2.1.3.	Hybrid modes: Yes/No[1] (if yes, short description)

4.1.3.	General description of hybrid electric power train
4.1.3.1.	Drawing of the hybrid power train system layout (engine/ motor/ transmission combination[1]):.....
4.1.3.2.	Description of the general hybrid power train working principle: .....
4.1.4.	Vehicle electric range (according Annex 9 to this Regulation): ..... km
4.1.5.	Manufacturer's recommendation for preconditioning: .....
4.2.	Internal combustion engine
4.2.1.	Engine manufacturer:.....
4.2.2.	Manufacturer's engine code (as marked on the engine, or other means of identification):.....
4.2.2.1.	Working principle: positive-ignition/compression-ignition, four-stroke/two-stroke[1]
4.2.2.2.	Number, arrangement and firing order of cylinders:.....
4.2.2.2.1.	Bore[2]: .....mm
4.2.2.2.2.	Stroke[2]:.....mm
4.2.2.3.	Engine capacity[3]:.....cm^3
4.2.2.4.	Volumetric compression ratio[4]:.....
4.2.2.5.	Drawings of combustion chamber and piston crown: .....
4.2.2.6.	Idle speed[4]:.....
4.2.2.7.	Carbon monoxide content by volume in the exhaust gas with the engine idling: ……. per cent (according to the manufacturer's specifications)[4] .....
4.2.2.8.	Maximum net power: ……. kW at ..... min^{-1}
4.2.3.	Fuel: petrol / unleaded petrol / diesel oil / LPG / NG[1]
4.2.3.1.	Research octane number (RON): .....
4.2.4.	Fuel feed
4.2.4.1.	By carburettor(s): Yes/No[1]
4.2.4.1.1.	Make(s): .....
4.2.4.1.2.	Type(s):.....
4.2.4.1.3.	Number fitted:.....
4.2.4.1.4.	Adjustments[4]:
4.2.4.1.4.1.	Jets: .....
4.2.4.1.4.2.	Venturis:.....
4.2.4.1.4.3.	Float-chamber level: .....
4.2.4.1.4.4.	Mass of float: .....
4.2.4.1.4.5.	Float needle:.....
4.2.4.1.5.	Cold start system: manual/automatic[1]
4.2.4.1.5.1.	Operating principle: .....

4.2.4.1.5.2.	Operating limits/settings[1,4]: .....
4.2.4.2.	By fuel injection (compression-ignition only): Yes/No[1]
4.2.4.2.1.	System description: .....
4.2.4.2.2.	Working principle: direct-injection/pre-chamber/swirl chamber[1]
4.2.4.2.3.	Injection pump
4.2.4.2.3.1.	Make(s): .....
4.2.4.2.3.2.	Type(s): .....
4.2.4.2.3.3.	Maximum fuel delivery[1,4]: …….. mm^3 / stroke or cycle at a pump speed of[1,4]: ……. min^{-1} or characteristic diagram: .....
4.2.4.2.3.4.	Injection timing[4]:.....
4.2.4.2.3.5.	Injection advance curve[4]: .....
4.2.4.2.3.6.	Calibration procedure: test bench/engine[1]
4.2.4.2.4.	Governor
4.2.4.2.4.1.	Type: .....
4.2.4.2.4.2.	Cut-off point: .....
4.2.4.2.4.2.1.	Cut-off point under load: ..... min^{-1}
4.2.4.2.4.2.2.	Cut-off point without load: ..... min^{-1}
4.2.4.2.4.3.	Idling speed: ..... min^{-1}
4.2.4.2.5.	Injector(s):
4.2.4.2.5.1.	Make(s): .....
4.2.4.2.5.2.	Type(s): .....
4.2.4.2.5.3.	Opening pressure[4]: ……. kPa or characteristic diagram: .....
4.2.4.2.6.	Cold start system
4.2.4.2.6.1.	Make(s): .....
4.2.4.2.6.2.	Type(s): .....
4.2.4.2.6.3.	Description: .....
4.2.4.2.7.	Auxiliary starting aid
4.2.4.2.7.1.	Make(s): .....
4.2.4.2.7.2.	Type(s): .....
4.2.4.2.7.3.	Description: .....
4.2.4.3.	By fuel injection (positive-ignition only): Yes/No[1]
4.2.4.3.1.	System description: .....

DRAFT FOR CONSULTATION

4.2.4.3.2. Working principle[1]: intake manifold (single/multi-point) / direct injection / other (specify)

Control unit – type (or No.): .....
Fuel regulator – type: .....
Air-flow sensor - type: .....
Fuel distributor - type: .....
Pressure regulator - type: .....
Micro-switch – type: .....
Idle adjusting screw - type: .....
Throttle housing - type: .....
Water temperature sensor - type: .....
Air temperature sensor - type: .....
Air temperature switch - type: .....

} information to be given in the case of continuous injection; in the case of other systems, equivalent details

Electromagnetic interference protection.....

Description and/or drawing: .....

4.2.4.3.3. Make(s): .....

4.2.4.3.4. Type(s): .....

4.2.4.3.5. Injectors: Opening pressure[4]: …… kPa or characteristic diagram[4]:.....

4.2.4.3.6. Injection timing: .....

4.2.4.3.7. Cold start system: .....

4.2.4.3.7.1. Operating principle(s): .....

4.2.4.3.7.2. Operating limits/settings[1,4]: .....

4.2.4.4. Feed pump

4.2.4.4.1. Pressure[4]: …… kPa or characteristic diagram: .....

4.2.5. Ignition

4.2.5.1. Make(s): .....

4.2.5.2. Type(s): .....

4.2.5.3. Working principle: .....

4.2.5.4. Ignition advance curve[4]: .....

4.2.5.5. Static ignition timing[4]: …… degrees before TDC

4.2.5.6. Contact-point gap[4]: .....

4.2.5.7. Dwell-angle[4]: .....

4.2.5.8. Spark plugs

4.2.5.8.1. Make: .....

4.2.5.8.2. Type: .....

4.2.5.8.3.	Spark plug gap setting: ..... mm
4.2.5.9.	Ignition coil
4.2.5.9.1.	Make: .....
4.2.5.9.2.	Type: .....
4.2.5.10.	Ignition condenser
4.2.5.10.1.	Make: .....
4.2.5.10.2.	Type: .....
4.2.6.	Cooling system: liquid/air[1]
4.2.7.	Intake system:
4.2.7.1.	Pressure charger: Yes/No[1]
4.2.7.1.1.	Make(s): .....
4.2.7.1.2.	Type(s): .....
4.2.7.1.3.	Description of the system (maximum charge pressure: …….. kPa, waste-gate)
4.2.7.2.	Inter-cooler: Yes/No[1]
4.2.7.3.	Description and drawings of inlet pipes and their accessories (plenum chamber, heating device, additional air intakes, etc.): .....
4.2.7.3.1.	Intake manifold description (drawings and/or photographs):.....
4.2.7.3.2.	Air filter, drawings: ……., or
4.2.7.3.2.1.	Make(s): .....
4.2.7.3.2.2.	Type(s): .....
4.2.7.3.3.	Intake silencer, drawings: ……., or
4.2.7.3.3.1.	Make(s): .....
4.2.7.3.3.2.	Type(s): .....
4.2.8.	Exhaust system
4.2.8.1.	Description and drawings of the exhaust system: .....
4.2.9.	Valve timing or equivalent data:
4.2.9.1.	Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to dead centres:.....
4.2.9.2.	Reference and/or setting ranges[1]:.....
4.2.10.	Lubricant used:
4.2.10.1.	Make: .....
4.2.10.2.	Type: .....
4.2.11.	Measures taken against air pollution:
4.2.11.1.	Device for recycling crankcase gases (description and drawings): .....
4.2.11.2.	Additional pollution control devices (if any, and if not covered by another heading:.....

4.2.11.2.1.	Catalytic converter: Yes/No[1]
4.2.11.2.1.1.	Number of catalytic converters and elements: .....
4.2.11.2.1.2.	Dimensions and shape of the catalytic converter(s) (volume, ...): .....
4.2.11.2.1.3.	Type of catalytic action: .....
4.2.11.2.1.4.	Total charge of precious metal: .....
4.2.11.2.1.5.	Relative concentration: .....
4.2.11.2.1.6.	Substrate (structure and material): .....
4.2.11.2.1.7.	Cell density: .....
4.2.11.2.1.8.	Type of casing for catalytic converter(s): .....
4.2.11.2.1.9.	Positioning of the catalytic converter(s) (place and reference distances in the exhaust system): .....
4.2.11.2.1.10.	Oxygen sensor: type .....
4.2.11.2.1.10.1.	Location of oxygen sensor: .....
4.2.11.2.1.10.2.	Control range of oxygen sensor: .....
4.2.11.2.2.	Air injection: yes/no[1]
4.2.11.2.2.1.	Type (pulse air, air pump, ...): .....
4.2.11.2.3.	Exhaust gas recirculation (EGR): Yes/No[1]
4.2.11.2.3.1.	Characteristics (flow, ...): .....
4.2.11.2.4.	Evaporative emission control system.
	Complete detailed description of the devices and their state of tune: .....
	Drawing of the evaporative control system: .....
	Drawing of the carbon canister: .....
	Drawing of the fuel tank with indication of capacity and material: .....
4.2.11.2.5.	Particulate trap: Yes/No[1]
4.2.11.2.5.1.	Dimensions and shape of the particulate trap (capacity): .....
4.2.11.2.5.2.	Type of particulate trap and design: .....
4.2.11.2.5.3.	Location of the particulate trap (reference distances in the exhaust system): .....
4.2.11.2.6.	Other systems (description and working principle): .....
4.3.	Traction battery / energy storage device
4.3.1.	Description of the energy storage device: (battery, capacitor, flywheel/generator …)
4.3.1.1.	Make: .....
4.3.1.2.	Type: .....
4.3.1.3.	Identification number: .....
4.3.1.4.	Kind of electrochemical couple: .....
4.3.1.5.	Energy: (for battery: voltage and capacity Ah in 2 h, for capacitor: J, ...)

4.3.1.6. Charger: on board/ external/ without[1]

4.4. Electric machines (describe each type of electric machine separately)

4.4.1. Make: .....

4.4.2. Type: .....

4.4.3. Primary use: traction motor / generator[1]

4.4.3.1. When used as traction motor: monomotors/ multimotors[1] (number): .....

4.4.4. Maximum power: ..... kW

4.4.5. Working principle:

4.4.5.1. Direct current/ alternating current /number of phases[1]:.....

4.4.5.2. Separate excitation / series / compound[1]

4.4.5.3. Synchronous / asynchronous[1]

4.5. Power train control unit

4.5.1. Make: .....

4.5.2. Type: .....

4.5.3. Identification number: .....

4.6. Power controller

4.6.1. Make: .....

4.6.2. Type: .....

4.6.3. Identification number: .....

4.7. Transmission

4.7.1. Clutch (type): .....

4.7.1.1. Maximum torque conversion: .....

4.7.2. Gearbox:

4.7.2.1. Type: .....

4.7.2.2. Location relative to the engine: .....

4.7.2.3. Method of control: .....

4.7.3. Gear ratios

	Gearbox ratios	*Final drive ratios*	*Total ratios*
Maximum for CVT (*)			
1			
2			
3			
4, 5, others			
Minimum for CVT (*)			
Reverse			

(*) CVT - Continuously variable transmission

5. Suspension

5.1.	Tyres and wheels
5.1.1.	Tyre/wheel combination(s) (for tyres indicate size designation, minimum load-capacity index, minimum speed category symbol; for wheels, indicate rim size(s) and off-set(s):
5.1.1.1.	Axles
5.1.1.1.1.	Axle 1:.....
5.1.1.1.2.	Axle 2:.....
5.1.1.1.3.	Axle 3:.....
5.1.1.1.4.	Axle 4: etc. .....
5.1.2.	Upper and lower limit of rolling circumference:
5.1.2.1.	Axles
5.1.2.1.1.	Axle 1:.....
5.1.2.1.2.	Axle 2:.....
5.1.2.1.3.	Axle 3:.....
5.1.2.1.4.	Axle 4: etc. .....
5.1.3.	Tyre pressure(s) as recommended by the manufacturer: ..... kPa
6.	Bodywork
6.1.	Seats:
6.1.1.	Number of seats:
7.	Inertia mass
7.1.	Equivalent inertia mass of complete front axle: .....
7.2.	Equivalent inertia mass of complete rear axle: .....

Strike out what does not apply.
[2] This value must be rounded to the nearest tenth of a millimetre.
[3] This value must be calculated with $\pi = 3.1416$ and rounded to the nearest cm^3.
[4] Specify the tolerance.

Annex 4

Communication*

(Maximum format: A4 (210 x 297 mm))

issued by : Name of administration:
.....
.....
.....

concerning[2]: Approval granted
Approval extended
Approval refused
Approval withdrawn
Production definitively discontinued

of a vehicle type pursuant to Regulation No. 101

Approval No: …… Extension No: ……

1. Trade name or mark of the vehicle: .....
2. Vehicle type: .....
3. Vehicle category: .....
4. Manufacturer's name and address: .....
5. If applicable, name and address of manufacturer's representative: .....
6. Description of the vehicle: .....
6.1. Mass of the vehicle in running order: .....
6.2. Maximum permitted mass: .....
6.3. Type of body:
6.3.1. For M_1: saloon, hatchback, station wagon, coupé, convertible, multipurpose vehicle[2,3]
6.3.2. For N_1: lorry, van.
6.4. Drive: front-wheel / rear-wheel / four-wheel[2]
6.5. Pure electric vehicle: Yes/No[2]
6.6. Hybrid electric vehicle: Yes/No[2]
6.6.1. Category of Hybrid Electric vehicle: Off-Vehicle Charging/Not Off-Vehicle charging[2]
6.6.2. Operating mode switch: with/without[2]
6.7. Internal combustion engine.

6.7.1.	Cylinder capacity: .....
6.7.2.	Fuel feed: carburettor / injection[2]
6.7.3.	Fuel recommended by the manufacturer: .....
6.7.4.	In the case of LPG/NG[2] the reference fuel used for the test
	(e.g. G20, G25): .....
6.7.5.	Maximum engine power: …….. kW at: … ..... min^{-1}
6.7.6.	Super-charger: Yes/No[2]
6.7.7.	Ignition: compression ignition / positive ignition (mechanical or electronic)[2]
6.8.	Power train (for pure electric vehicle or hybrid electric vehicle)[2]
6.8.1.1.	Maximum net power: …… kW, at: …… to ..... min^{-1}
6.8.1.2.	Maximum thirty minutes power: ..... kW
6.8.1.3.	Working principle: .....
6.9.	Traction battery (for pure electric vehicle or hybrid electric vehicle)
6.9.1.	Nominal voltage: V
6.9.2.	Capacity (2 h rate): ..... Ah
6.9.3.	Battery maximum thirty minutes power: ..... kW
6.9.4.	Charger: on board/external[2]
6.10.	Transmission:
6.10.1.	Type of gearbox: manual / automatic / variable transmission[2]
6.10.2.	Number of gears: .....
6.10.3.	Overall gear ratios (including tyre tread circumference under load): road speeds (km/h) per 1,000 engine speed (min^{-1}):
	First gear: .....
	Second gear: .....
	Third gear: .....
	Fourth gear: .....
	Fifth gear: .....
	Overdrive: .....
6.10.4.	Final drive ratio: .....
6.11.	Tyres:
	Type: .....
	Dimensions: .....
	Rolling circumference under load: .....
7.	Type-approval values:
7.1.	Internal combustion engine vehicle and Not Externally Chargeable (NOVC) Hybrid Electric Vehicle[2]
7.1.1.	CO_2 mass emissions

7.1.1.1.	Urban conditions: ..... g/km
7.1.1.2.	Extra-urban conditions: ..... g/km
7.1.1.3.	Combined: ..... g/km
7.1.2.	Fuel consumption[4,5]
7.1.2.1.	Fuel consumption (urban conditions):
	..... l/100 km or m^3/100 km or kg/100 km*
7.1.2.2.	Fuel consumption (extra-urban conditions):
	..... l/100 km or m^3/100 km or kg/100 km*
7.1.2.3.	Fuel consumption (combined):
	..... l/100 km or m^3/100 km or kg/100 km*
*	Delete where not applicable (when more than one entry is applicable, there are cases where nothing needs to be deleted).
7.1.3.	For vehicles powered by an internal combustion engine only which are equipped with periodically regenerating systems as defined in paragraph 2.16. of this Regulation, the test results must be multiplied by the factor K_i obtained from Annex 10 to this Regulation.
7.2.	Pure electric vehicles[2]
7.2.1.	Measurement of electric energy consumption.
7.2.1.1.	Electric energy consumption: .....Wh/km
7.2.1.2.	Total time out of tolerance for the conduct of the cycle: ..... sec
7.2.2.	Measurement of range:
7.2.2.1.	Electric Range: ..... km
7.2.2.2.	Total time out of tolerance for the conduct of the cycle: .....sec
7.3.	Externally chargeable (OVC) hybrid electric vehicle:
7.3.1.	CO_2 mass emission (condition A, combined[6]):..... g/ km
7.3.2.	CO_2 mass emission (condition B, combined[5]): ..... g/ km
7.3.3.	CO_2 mass emission (weighted, combined[5]): ..... g/ km
7.3.4.	Fuel consumption (condition A ,combined[5]): ..... l/100 km
7.3.5.	Fuel consumption (condition B ,combined[5]): ..... l/100 km
7.3.6.	Fuel consumption (weighted, combined[5]): ..... l/100 km
7.3.7.	Electric energy consumption (condition A, combined[5]):.....Wh/ km
7.3.8.	Electric energy consumption (condition B, combined[5]): .....Wh/ km
7.3.9.	Electric energy consumption (weighted and combined[5]): .....Wh/ km
7.3.10.	OVC Range: .....km
8.	Vehicle submitted for approval on: .....
9.	Technical Service responsible for conducting approval tests:
10.	Number of report issued by that Service: .....

11. Date of report issued by that Service: .....

12. Approval granted / extended / refused / withdrawn[2]

13. Reasons for extension (if applicable): .....

14. Remarks: .....

15. Positioning of approval mark on the vehicle: .....

16. Place: .....

17. Date: .....

18. Signature: .....

* For vehicles that are approved within a family according to paragraph 7.6. of this Regulation, this communication must be supplied for each individual member of the vehicle family.

[1] Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in this Regulation).

[2] Strike out what does not apply.

[3] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.2, para. 2

[4] Repeat for petrol and gaseous fuel in the case of a vehicle that can run either on petrol or on a gaseous fuel.

[5] For vehicles fuelled with NG the unit l/100 km is replaced by m^3/km.

[6] Measured over the combined cycle, i.e. Part One (urban) and Part Two (extra-urban) together.

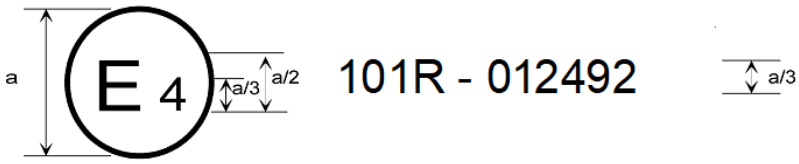
Annex 5

Arrangements of approval marks

Model A

(See paragraph 4.4. of this Regulation)

a = 8 mm min.

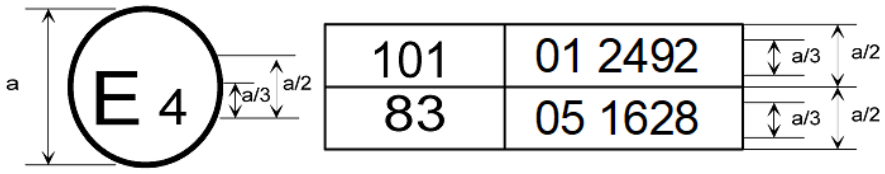


The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) with regard to the measurement of emissions of CO_2 and fuel consumption or to the measurement of electric energy consumption and electric range pursuant to Regulation No. 101 and under approval number 012492. The first two digits of the approval number indicate that the approval was granted according to the requirements of Regulation No. 101 as amended by the 01 series of amendments.

Model B

(See paragraph 4.5. of this Regulation)

a = 8 mm min.



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. 101 and 83*. The first two digits of the approval numbers indicate that, at the dates when the respective approvals were given, Regulation No. 101 with the 01 series of amendments incorporated and Regulation No. 83 already included the 05 series of amendments.

* The second number is given merely as an example

Annex 6

Method of measuring emissions of carbon dioxide and fuel consumption of vehicles powered by an internal combustion engine only or hydrogen fuel cell vehicles

1. Specification of the test

1.1. Emissions of carbon dioxide (CO_2) and fuel consumption of vehicles powered by an internal combustion engine only shall be determined according to the procedure for the Type I test as defined in Annex 4a to UN Regulation No. 83 according to the series of amendments to which the vehicle is approved or in the case that the vehicle is not approved according to UN Regulation No. 83, the series of amendments in force at the time of the approval of the vehicle.

In case vehicle's emissions are approved according to WLTP procedures as defined in UN GTR No. 15, the methodology for Road Load determination and dyno setting, defined in Annex 7 - Appendix 2 may be used instead of the methodology of Annex 4a – Appendix 7 to UN Regulation No.83

1.2. Emissions of carbon dioxide (CO_2) and fuel consumption shall be determined separately for the Part One (urban driving) and the Part Two (extra-urban driving) of the specified driving cycle.

1.3. In addition to the conditions specified in Annex 4a to Regulation No. 83 in force at the time of the approval of the vehicle, the following conditions apply:

1.3.1. Only the equipment necessary for the operation of the vehicle during the test shall be in use. If there is a manually controlled device for the engine intake air temperature, it shall be in the position prescribed by the manufacturer for the ambient temperature at which the test is performed. In general, the auxiliary devices required for the normal operation of the vehicle shall be in use.

1.3.2. If the radiator fan is temperature controlled, it shall be in the condition of normal operation on the vehicle. The passenger compartment heating system shall be switched off, as shall any air conditioning system, but such systems compressor shall be functioning normally.

1.3.3. If a super-charger is fitted, it shall be in the normal operating condition for the test conditions.

1.3.4. All the lubricants shall be those recommended by the manufacturer of the vehicle and shall be specified in the test report.

1.4. Calculation of CO_2 and fuel consumption values

1.4.1. The mass emission of CO_2, expressed in g/km, shall be calculated from the measurement results using the provisions defined in paragraph 6.6. of Annex 4a to Regulation No. 83 in force at the time of the approval of the vehicle

1.4.1.1. For this calculation the density of CO_2 shall be Q_{CO2} = 1.964 g/litre.

1.4.2. The fuel consumption values shall be calculated from the emissions of hydrocarbons, carbon monoxide, and carbon dioxide determined from the measurement results using the provisions defined in paragraph 6.6. of Annex 4a to Regulation No. 83 in force at the time of the approval of the vehicle.

1.4.3. The fuel consumption, expressed in litres per 100 km (in the case of petrol (E5/E10), LPG, ethanol (E85) and diesel (B5/B7)), in m^3 per 100 km (in the case of NG/biomethane and H2NG) or in kg per 100 km (in the case of hydrogen) is calculated by means of the following formulae:

(a) For vehicles with a positive ignition engine fuelled with petrol (E5):$FC = (0.118/D) \cdot [(0.848 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$;

(b) For vehicles with a positive ignition engine fuelled with petrol (E10):

$FC = (0.120/D) \cdot [(0.830 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$;

(c) for vehicles with a positive ignition engine fuelled with LPG:

$FC_{norm} = (0.1212 / 0.538) \cdot [(0.825 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$.

If the composition of the fuel used for the test differs from the composition that is assumed for the calculation of the normalized consumption, on the manufacturer's request a correction factor cf may be applied, as follows:

$FC_{norm} = (0.1212 / 0.538) \cdot (cf) \cdot [(0.825 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$.

The correction factor cf, which may be applied, is determined as follows:

$cf = 0.825 + 0.0693 \cdot n_{actual}$;

Where:

n_{actual} = the actual H/C ratio of the fuel used;

(d) For vehicles with a positive ignition engine fuelled with NG/biomethane:

$FC_{norm} = (0.1336 / 0.654) \cdot [(0.749 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$;

(e) For vehicles with a compression ignition engine fuelled with diesel (B5):

$FC = (0.116/D) \cdot [(0.861 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$;

(f) For vehicles with a compression ignition engine fuelled with diesel (B7):

$FC = (0.116/D) \cdot [(0,859 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$

(g) For vehicles with a positive ignition engine fuelled with ethanol (E85):

$FC = (0.1742/D) \cdot [(0.574 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$.

(h) For vehicles with a positive ignition engine fuelled by H2NG:

$$FC = \frac{910.4 \cdot A + 13.600}{44.655 \cdot A^2 + 667.08 \cdot A}\left(\frac{7.848 \cdot A}{9.104 \cdot A + 136} \cdot HC + 0.429 \cdot CO + 0.273 \cdot CO_2\right)$$

(i) For vehicles fuelled by gaseous hydrogen:

$$FC = 0.024 \frac{V}{d}\left[\frac{1}{Z_1}\frac{p_1}{T_1} - \frac{1}{Z_2}\frac{p_2}{T_2}\right]$$

Under previous agreement with the type-approval authority, and for vehicles fuelled either by gaseous or liquid hydrogen, the manufacturer may choose as alternative to the method above, either the formula

$FC = 0.1 \cdot (0.1119 \cdot H_2O + H_2)$

for vehicles powered by internal combustion engine only, or a method according to standard protocols such as SAE J2572 or ISO 23828.

In these formulae:

FC = the fuel consumption in litre per 100 km (in the case of petrol (E5/E10), ethanol, LPG, diesel (B5/B7) or biodiesel) in m^3 per 100 km (in the case of natural gas and H2NG) or in kg per 100 km in the case of hydrogen.

HC = the measured emission of hydrocarbons in g/km

CO = The measured emission of carbon monoxide in g/km

CO_2 = The measured emission of carbon dioxide in g/km

H_2O = The measured emission of H_2O in g/km

H_2 = The measured emission of H_2 in g/km

A = Quantity of NG/biomethane within the H2NG mixture, expressed in per cent volume

D = The density of the test fuel. In the case of gaseous fuels this is the density at 15 °C.

d = The theoretical distance covered by a vehicle tested under the Type I test in km.

p_1 = Pressure in gaseous fuel tank before the operating cycle in Pa;

p_2 = Pressure in gaseous fuel tank after the operating cycle in Pa;

T_1 = Temperature in gaseous fuel tank before the operating cycle in K.

T_2 = Temperature in gaseous fuel tank after the operating cycle in K.

Z_1 = Compressibility factor of the gaseous fuel at p_1 and T_1

Z_2 = compressibility factor of the gaseous fuel at p_2 and T_2

V = Inner volume of the gaseous fuel tank in m^3

The compressibility factor shall be obtained from the following table:

		T (K)									
		5	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*
p (bar)	*33*	0.859	1.051	1.885	2.648	3.365	4.051	4.712	5.352	5.973	6.576
	53	0.965	0.922	1.416	1.891	2.338	2.765	3.174	3.57	3.954	4.329
	73	0.989	0.991	1.278	1.604	1.923	2.229	2.525	2.81	3.088	3.358
	93	0.997	1.042	1.233	1.47	1.711	1.947	2.177	2.4	2.617	2.829
	113	1	1.066	1.213	1.395	1.586	1.776	1.963	2.146	2.324	2.498
	133	1.002	1.076	1.199	1.347	1.504	1.662	1.819	1.973	2.124	2.271
	153	1.003	1.079	1.187	1.312	1.445	1.58	1.715	1.848	1.979	2.107
	173	1.003	1.079	1.176	1.285	1.401	1.518	1.636	1.753	1.868	1.981
	193	1.003	1.077	1.165	1.263	1.365	1.469	1.574	1.678	1.781	1.882
	213	1.003	1.071	1.147	1.228	1.311	1.396	1.482	1.567	1.652	1.735
	233	1.004	1.071	1.148	1.228	1.312	1.397	1.482	1.568	1.652	1.736
	248	1.003	1.069	1.141	1.217	1.296	1.375	1.455	1.535	1.614	1.693
	263	1.003	1.066	1.136	1.207	1.281	1.356	1.431	1.506	1.581	1.655
	278	1.003	1.064	1.13	1.198	1.268	1.339	1.409	1.48	1.551	1.621
	293	1.003	1.062	1.125	1.19	1.256	1.323	1.39	1.457	1.524	1.59
	308	1.003	1.06	1.12	1.182	1.245	1.308	1.372	1.436	1.499	1.562
	323	1.003	1.057	1.116	1.175	1.235	1.295	1.356	1.417	1.477	1.537
	338	1.003	1.055	1.111	1.168	1.225	1.283	1.341	1.399	1.457	1.514
	353	1.003	1.054	1.107	1.162	1.217	1.272	1.327	1.383	1.438	1.493

In the case that the needed input values for p and T are not indicated in the table, the compressibility factor shall be obtained by linear interpolation between the compressibility factors indicated in the table, choosing the ones that are the closest to the sought value.

Annex 7

Method of measuring the electric energy consumption of vehicles powered by an electric power train only

1. Measurement of electric energy consumption and pure electric range

The test method described hereafter permits to measure the electric energy consumption, expressed in Wh/km, and the pure electric range, expressed in km, of vehicles powered by an electric power train only.

1.1. The test procedure to determine the pure electric range and electric energy consumption shall be selected in accordance with the estimated pure electric range of the test vehicle from the following table.

If the estimated pure electric range is	Applicable test procedure
…less than the length of 6 NEDC test cycles.	Consecutive cycle test procedure in accordance with paragraph 5.2.3.1. of this Annex.
…equal to or greater than the length of 6 NEDC test cycles.	Shortened test procedure in accordance with paragraph 5.2.3.2. of this Annex.

The manufacturer shall give evidence to the approval authority concerning the estimated pure electric range prior to the test. The pure electric range determined by the applied test procedure shall confirm that the correct test procedure was applied.

1.2. Parameters, units and accuracy of measurements

Parameter	*Units*	*Accuracy*	*Resolution*
Time	s	±0.1 s	0.1 s
Distance	m	±0.1 per cent	1 m
Temperature	°C	±1 °C	1 °C
Speed	km/h	±1 per cent	0.2 km/h
Mass	kg	±0.5 per cent	1 kg
Electric Energy [(a)]	Wh	±1 per cent	0.001 kWh [(b)]
Electric current	A	±0.3 per cent FSD or ±1 per cent of reading [(c,d)]	0.1 A
Electric voltage	V	±0.3 per cent FSD or ±1 per cent of reading [(c)]	0.1 V

(a) Equipment: static meter for active energy.
(b) AC watt-hour meter, Class 1 according to IEC 62053-21 or equivalent.
(c) Whichever is greater.
(d) Current integration frequency 20 Hz or more.

2. NEDC test cycle

2.1. Composition

The NEDC test cycle is composed of two parts (see Figure 1):

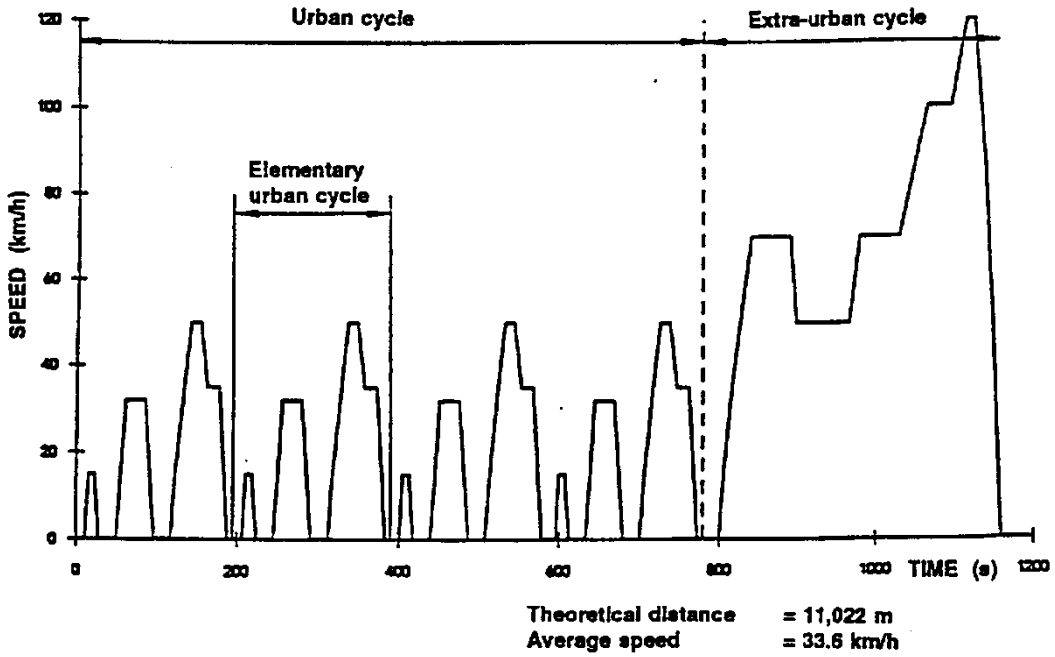
(a) An urban cycle made of four elementary urban cycles;

(b) An extra-urban cycle.

In case of a manual gear box with several gears, the operator changes the gear according to the manufacturer's specifications.

If the vehicle has several driving modes, which may be selected by the driver, the operator shall select the one to best match the target curve.

Figure 1
Text sequence



2.2. Urban cycle

The urban cycle is composed of four elementary cycles of 195 seconds each and lasts 780 seconds in total.

Description of the elementary urban cycle is given in Figure 2 and Table 1.

Figure 2
Elementary urban cycle (195 seconds)

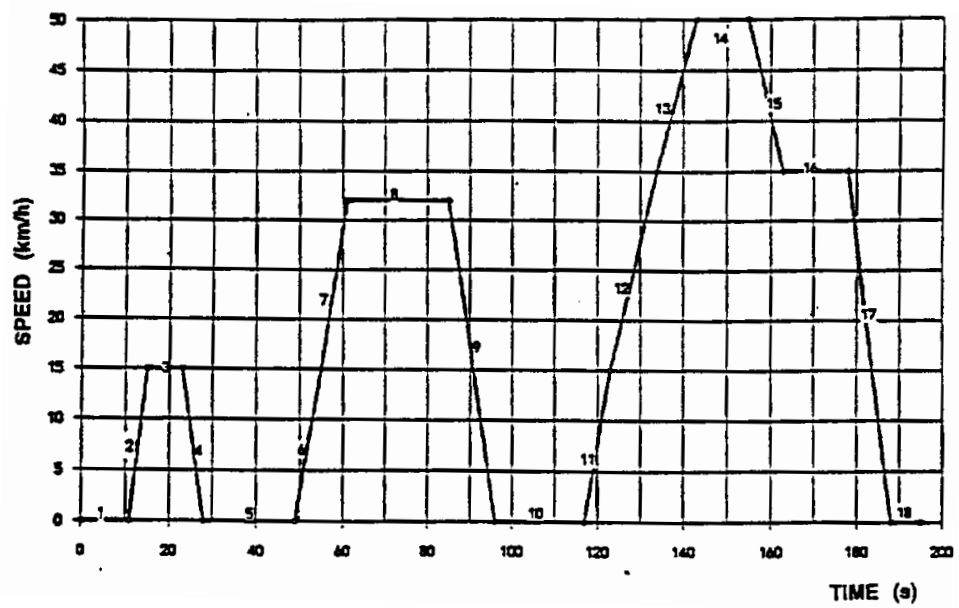


Table 1
Elementary urban cycle

Operation N°	*Operation type*	*Elementary urban cycle*			*Operation duration (s)*	*Mode duration (s)*	*Total time (s)*
		Mode N°	*Acceleration (m/s^2)*	*Speed (km/h)*			
1	Stop	1	0.00	0	11	11	11
2	Acceleration	2	1.04	0-15	4	4	15
3	Constant speed	3	0.00	15	8	8	23
4	Deceleration	4	-0.83	15-0	5	5	28
5	Stop	5	0.00	0	21	21	49
6	Acceleration	6	0.69	0-15	6	12	55
7	Acceleration		0.79	15-32	6		61
8	Constant speed	7	0.00	32	24	24	85
9	Deceleration	8	-0.81	32-0	11	11	96
10	Stop	9	0.00	0	21	21	117
11	Acceleration	10	0.69	0-15	6	26	123
12	Acceleration		0.51	15-35	11		134
13	Acceleration		0.46	35-50	9		143
14	Constant speed	11	0.00	50	12	12	155
15	Deceleration	12	-0.52	50-35	8	8	163
16	Constant speed	13	0.00	35	15	15	178
17	Deceleration	14	-0.97	35-0	10	10	188
18	Stop	15	0.00	0	7	7	195

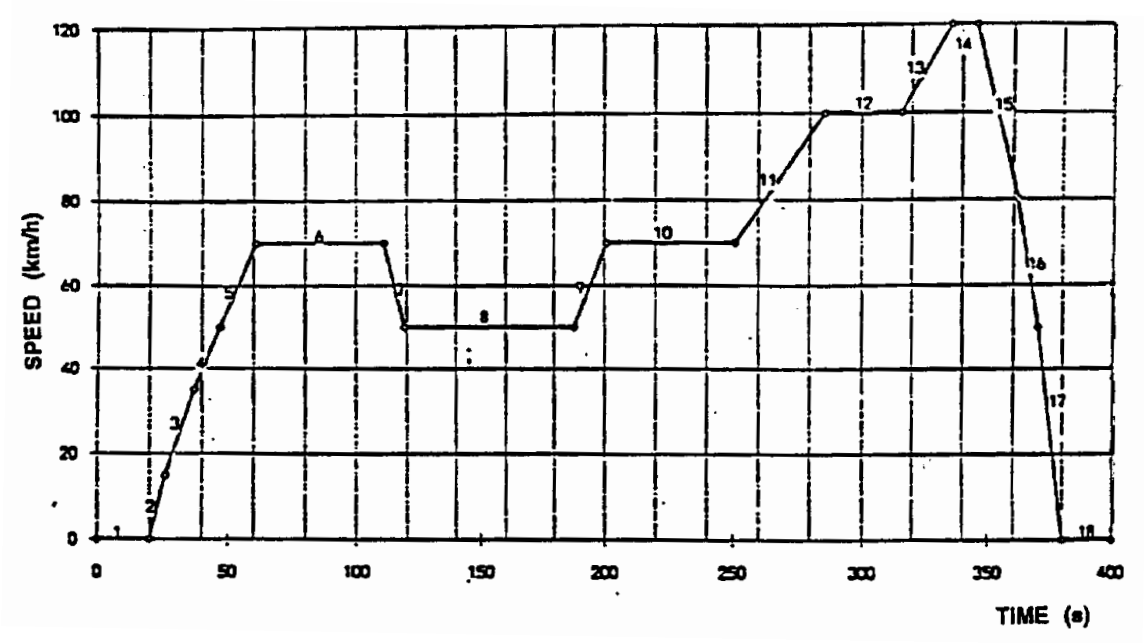
Generalities	In time(s)	In percentage
Stop	60	30.77
Acceleration	42	21.54
Constant speed	59	30.26
Deceleration	34	17.44
Total	195	100.00

Average speed (km/h)	18.77
Working time (s)	195
Theoretical distance by elementary urban cycle (m)	1,017
Theoretical distance for four elementary urban cycles (m)	4,067

2.3. Extra-urban cycle

The description of the extra-urban cycle is given in Figure 3 and Table 2.

Figure 3
Extra-urban cycle (400 seconds)



Note: The procedure to be adopted when the vehicle failed to meet the speed requirements of this curve is detailed in item 1.4.

Table 2

Operation N°	*Operation type*	*Extra-urban cycle*			*Operation duration*	*Mode duration*	*Total time*
		Mode N°	*Acceleration (m/s^2)*	*Speed (km/h)*	*(s)*	*(s)*	*(s)*
1	Stop	1	0.00	0	20	20	20
2	Acceleration	2	0.69	0-15	6	41	26
3	Acceleration		0.51	15-35	11		37
4	Acceleration		0.42	35-50	10		47
5	Acceleration		0.40	50-70	14		61
6	Constant speed	3	0.00	70	50	50	111
7	Deceleration	4	-0.69	70-50	8	8	119
8	Constant speed	5	0.00	50	69	69	188
9	Acceleration	6	0.43	50-70	13	13	201
10	Constant speed	7	0.00	70	50	50	251
11	Acceleration	8	0.24	70-100	35	35	286
12	Constant speed	9	0.00	100	30	30	316
13	Acceleration	10	0.28	100-120	20	20	336
14	Constant speed	11	0.00	120	10	10	346
15	Deceleration	12	-0.69	120-80	16	34	362
16	Deceleration		-1.04	80-50	8		370
17	Deceleration		-1.39	50-0	10		380
18	Stop	13	0.00	0	20	20	400

Generalities	In time(s	In percentage
Stop	40	10.00
Acceleration	109	27.25
Constant speed	209	52.25
Deceleration	42	10.50
Total	400	100.00

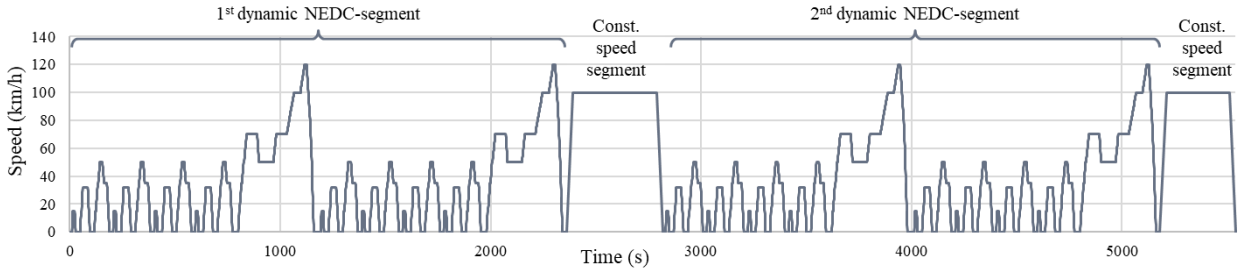
Average speed (km/h)	62.60
Working time (s)	400
Theoretical distance (m)	6,956

DRAFT FOR CONSULTATION

3. Shortened NEDC test sequence

The shortened NEDC test sequence consists of two dynamic NEDC-segments (DS_1 and DS_2) combined with two constant speed segments (CSS_M and CSS_E) as shown in the following figure.

Figure 3a
Shortened NEDC test sequence



The dynamic NEDC segments DS_1 and DS_2 are used to calculate the electric energy consumption. The constant speed segments CSS_M and CSS_E are intended to reduce test duration by depleting the REESS more rapidly than driving consecutively NEDC test cycles.

3.1. Dynamic NEDC segments

Each dynamic NEDC segment DS_1 and DS_2 consists of two NEDC test cycles in accordance with paragraph 2. of this annex.

3.2. Constant speed segment

The constant speeds during segments CSS_M and CSS_E shall be identical.

(a) Speed specification

The minimum speed of the constant speed segments shall be 100 km/h. At the request of manufacturer and with approval of the approval authority, a higher constant speed in the constant speed segments may be selected.

The acceleration to the constant speed level shall be smooth and accomplished within 1 minute after completion of the dynamic segments and, in the case of a break in accordance with paragraph 5.2.3.2.1. of this annex, after initiating the powertrain start procedure.

If the maximum speed of the vehicle is lower than the required minimum speed for the constant speed segments according to the speed specification of this paragraph, the required speed in the constant speed segments shall be equal to the maximum speed of the vehicle.

(b) Distance determination of CSS_E and CSS_M

The length of the constant speed segment CSS_E shall be determined based on the percentage of the usable REESS energy UBE_{STP} according to paragraph 5.2.5.2.2. of this Annex. The remaining energy in the traction REESS after dynamic NEDC segment DS_2 shall be equal to or less than 10 per cent of UBE_{STP}. The manufacturer shall provide evidence to the approval authority after the test that this requirement is fulfilled.

The length of the constant speed segment CSS_M may be calculated using the following equation:

$d_{CSSM} = D_{e,est} - d_{DS1} - d_{DS2} - d_{CSSE}$

where:

$D_{e,est}$ is the estimated pure electric range of the considered vehicle, km;

d_{DS1} is the length of dynamic NEDC segment 1, km;

d_{DS2} is the length of dynamic NEDC segment 2, km;

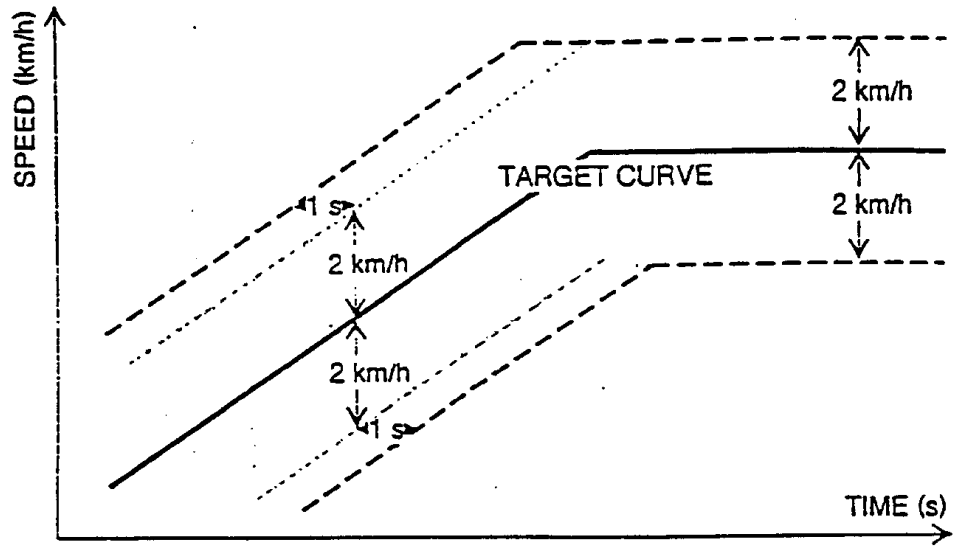
d_{CSSE} is the length of constant speed segment CSS_E, km.

4. Tolerance

4.1. Tolerances for driving the NEDC test cycle

Tolerances are given in Figure 4.

Figure 4
Speed tolerance



Tolerances on speed (±2 km/h) and on time (±1 s) are geometrically combined at each point as represented in Figure 4.

Below 50 km/h, deviations beyond this tolerance are permitted as follows:

(a) At gear changes for a duration less than 5 seconds,

(b) And up to five times per hour at other times, for a duration less than 5 seconds each.

The total time out of tolerance has to be mentioned in the test report.

Over 50 km/h, it is accepted to go beyond tolerances provided the accelerator pedal is fully depressed.

4.2. Tolerances for driving with constant speed in a constant speed segment

Tolerances on the constant speed are ±2 km/h.

Deviations beyond this tolerance are permitted up to five times per hour for a duration less than 4 seconds each."

5. Test method

5.1.1. Condition of the vehicle

5.1.1.1. The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are at the ambient temperature.

5.1.1.2. The viscosity of the oils for the mechanical moving parts shall conform to the specification of the vehicle manufacturer.

5.1.1.3. The lighting and light-signalling and auxiliary devices shall be off, except those required for testing and usual day-time operation of the vehicle.

5.1.1.4. All energy storage systems available for other than traction purposes (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the manufacturer.

5.1.1.5. If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the car manufacturer in order to keep the temperature of the battery in the normal operating range.

The manufacturer's agent shall be in a position to attest that the thermal management system of the battery is neither disabled nor reduced.

5.1.1.6. The vehicle must have undergone at least 300 km or one full charge distance, whichever is longer, before the test with those batteries that are installed in the test vehicle.

5.2. Operation mode

All the tests are conducted at a temperature of between 20 °C and 30 °C.

The general test method includes the following steps:

(a) Discharging the battery in accordance with paragraph 5.2.1. of this annex;

(b) Application of a normal charge in accordance with paragraph 5.2.2. of this annex;

(c) Application of either the consecutive cycle test procedure or the shortened test procedure in accordance with paragraph 1.1. of this annex;

(d) Application of a normal charge in accordance with paragraph 5.2.2. of this annex;

(e) Determination of the electric energy consumption and the pure electric range.

Between the steps, if the vehicle shall move, it is pushed to the following test area (without regenerative recharging).

The chassis dynamometer shall be set with the method described in Appendix 1 to this annex."

5.2.1. Discharge of the battery

The discharge procedure shall be performed according to the manufacturer's recommendation. The manufacturer shall guarantee that the REESS is as fully depleted as is possible by the discharge procedure.

5.2.2. Application of a normal charge

Normal charging is the transfer of electricity to an electrified vehicle with a power of less than or equal to 22 kW.

Where there are several possible methods to perform a normal AC charge (e.g. cable, induction, etc.), the charging procedure via cable shall be used.

Where there are several AC charging power levels available, the highest normal charging power shall be used. An AC charging power lower than the highest normal AC charging power may be selected if recommended by the manufacturer and by approval of the responsible authority.

5.2.2.1. Charging procedure

The REESS shall be charged at an ambient temperature compromised between 20 °C and 30 °C with the on-board charger if fitted.

In the following cases, a charger recommended by the manufacturer and using the charging pattern prescribed for normal charging shall be used if:

(a) No on-board charger is fitted, or

(b) Charging time exceeds maximum time defined in paragraph 5.2.2.2.

The procedures in this paragraph exclude all types of special charges that could be automatically or manually initiated, e.g. equalization charges or servicing charges.

The car manufacturer shall declare that during the test, a special charge procedure has not occurred.

5.2.2.2. End of charge criteria

The end of charge criteria corresponds to a charging time of 12 hours except if a clear indication is given to the driver by the standard instrumentation that the battery is not yet fully charged.

In this case,

$$the\ maximum\ time\ is\ = \frac{3 \cdot claimed\ battery\ capacity\ (Wh)}{mains\ power\ supply\ (W)}$$

5.2.3. Application of the cycle test procedure to determine the pure electric range and the electric energy consumption

The end of charging time t_0 (plug off) is reported.

5.2.3.1. Consecutive cycle test procedure

5.2.3.1.1. Speed trace and breaks

The test shall be performed by driving consecutive NEDC test cycles until the break-off criterion according to paragraph 5.2.3.1.3. of this annex is reached.

To respect human needs, up to three interruptions are permitted between NEDC test cycles, of no more than fifteen minutes in total.

Breaks for the driver and/or operator are permitted only between test cycles and with a maximum total break time of 10 minutes. During the break, the powertrain shall be switched off.

5.2.3.1.2. REESS current and voltage measurement

From the beginning of the test until the break-off criterion according to 5.2.3.1.3. is reached, the electric current of all REESSs and the electric voltage of all REESSs shall be determined according to Appendix 3 to this annex.

5.2.3.1.3. Break-off criterion

The break-off criterion is reached when the vehicle is not able to meet the target curve up to 50 km/h, or when an indication from the standard on-board instrumentation is given to the driver to stop the vehicle.

The accelerator control shall be deactivated. The vehicle shall be braked to standstill within 60 seconds.

At a speed over 50 km/h, when the vehicle does not reach the required acceleration or speed of the test cycle, the accelerator pedal shall remain fully depressed until the reference curve has been reached again.

5.2.3.2. Shortened test procedure

5.2.3.2.1. Speed trace and breaks

The test shall be performed by driving the shortened NEDC test sequence according to paragraph 3. of this annex until the break-off criterion according to paragraph 5.2.3.2.3. of this annex is reached.

Breaks for the driver and/or operator are permitted only in the constant speed segments as prescribed in the following table.

Breaks for the driver and/or test operator

Distance driven in constant speed segment CSS_M (km)	*Maximum total break (min)*
Up to 100	10
Up to 150	20
Up to 200	30
Up to 300	60
More than 300	Shall be based on the manufacturer's recommendation

5.2.3.2.2. REESS current and voltage measurement

From the beginning of the test until the break-off criterion according to paragraph 5.2.3.2.3. to this annex is reached, the electric current of all REESSs and the electric voltage of all REESSs shall be determined according to Appendix 3 to this annex.

5.2.3.2.3. Break-off criterion

The break-off criterion is reached when the vehicle exceeds the prescribed speed trace tolerance as specified in paragraph 4.2. to this annex for 4 consecutive seconds or more in the second constant speed segment CSS_E. The

accelerator control shall be deactivated. The vehicle shall be braked to a standstill within 60 seconds."

5.2.4. Charge of the battery

The vehicle shall be connected to the mains within the 30 minutes after the break-off criterion in accordance with paragraph 5.2.3.1.3. or 5.2.3.2.3. respectively.

The vehicle shall be charged according to normal charge procedure in accordance with paragraph 5.2.2. of this annex.

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy E delivered from the mains, as well as its duration.

The determination of recharged electric energy shall be stopped if the end of charge criterion in accordance with 5.2.2.2. is reached.

5.2.5. Determination of pure electric range and electric energy consumption

5.2.5.1. Calculation of electric energy consumption

For the determination of the electric energy consumption based on the current and voltage determined according to Appendix 3 of this Annex, the following equations shall be used:

$$EC_{DC,j} = \frac{\Delta E_{REESS,j}}{d_j}$$

where:

$EC_{DC,j}$ is the electric energy consumption over the considered period j based on the REESS depletion, Wh/km;

$\Delta E_{REESS,j}$ is the electric energy change of all REESSs during the considered period j, Wh;

d_j is the distance driven in the considered period j, km;

and

$$\Delta E_{REESS,j} = \sum_{j=1}^{n} \Delta E_{REESS,j,i}$$

where:

$\Delta E_{REESS,j,i}$ is the electric energy change of REESS i during the considered period j, Wh;

and

$$\Delta E_{REESS,j,i} = \frac{1}{3600} \times \int_{t_0}^{t_{end}} U(t)_{REESS,j,i} \times I(t)_{REESS,j,i}\, dt$$

where:

$U(t)_{REESS,j,i}$ is the voltage of REESS i during the considered period j determined according to Appendix 3 to this annex, V;

t_0 is the time at the beginning of the considered period j, s;

t_{end} is the time at the end of the considered period j, s;

$I(t)_{REESS,j,i}$ is the electric current of REESS i during the considered period j determined according to Appendix 3 to this annex, A;

i is the index number of the considered REESS;

n is the total number of REESS;

j is the index for the considered period, where a period can be any combination of phases or cycles;

$\frac{1}{3600}$ is the conversion factor from Ws to Wh.

5.2.5.2. Calculation of the pure electric range

5.2.5.2.1. Determination of the pure electric range when the consecutive cycle test procedure according to paragraph 5.2.3.1. of this annex is applied

The final pure electric range D_e shall be rounded to the nearest whole number in km and shall be calculated using the following equations:

$$D_e = \frac{UBE_{CCP}}{EC_{DC}}$$

where:

UBE_{CCP} is the usable REESS energy determined from the beginning of the consecutive cycle test procedure until the break-off criterion according to paragraph 5.2.3.1.3. of this annex is reached, Wh;

EC_{DC} is the electric energy consumption determined from completely driven NEDC test cycles of the consecutive cycle Type 1 test procedure, Wh/km;

and

$$UBE_{CCP} = \sum_{j=1}^{k} \Delta E_{REESS,j}$$

where:

$\Delta E_{REESS,j}$ is the electric energy change of all REESSs during NEDC test cycle j of the consecutive cycle test procedure, Wh;

j is the index number of the NEDC test cycle considered;

k is the number of NEDC test cycles driven from the beginning up to and including the phase where the break-off criterion is reached;

and

$$EC_{DC} = \sum_{j=1}^{n} EC_{DC,j} \times k_j$$

where:

$EC_{DC,j}$ is the electric energy consumption for NEDC test cycle j of the consecutive cycle test procedure according to paragraph 5.2.5.1. of this annex, Wh/km;

k_j is the weighting factor for the NEDC test cycle j of the consecutive cycle test procedure;

j is the index number of the NEDC test cycle;

n is the whole number of complete NEDC test cycles driven;

and

in case of two complete NEDC test cycles driven:

$k_1 = \frac{\Delta E_{REESS,1}}{UBE_{CCP}}$, $k_2 = \frac{\Delta E_{REESS,2}}{UBE_{CCP}}$

in case of at least three NEDC test cycles driven:

$k_1 = \frac{\Delta E_{REESS,1}}{UBE_{CCP}}$, $k_2 = \frac{\Delta E_{REESS,2}}{UBE_{CCP}}$ and $k_j = \frac{1-k_1-k_2}{n-2}$ for $j = 3 \dots n$

where:

$\Delta E_{REESS,1}$ is the electric energy change of all REESSs during the first NEDC test cycle of the consecutive test cycle procedure, Wh;

$\Delta E_{REESS,2}$ is the electric energy change of all REESSs during the second NEDC test cycle of the consecutive test cycle procedure, Wh.

5.2.5.2.2. Determination of the pure electric range when the shortened test procedure according to paragraph 5.2.3.2. of this annex is applied

The final pure electric range D_e shall rounded to the nearest whole number in km and shall be calculated using the following equations:

$$D_e = \frac{UBE_{STP}}{EC_{DC}}$$

where:

UBE_{STP} is the usable REESS energy determined from the beginning of the shortened test procedure until the break-off criterion as defined in paragraph 5.2.3.2.3. of this annex is reached, Wh;

EC_{DC} is the weighted electric energy consumption of DS_1 and DS_2 of the shortened test procedure, Wh/km;

and

$$UBE_{STP} = \Delta E_{REESS,DS_1} + \Delta E_{REESS,DS_2} + \Delta E_{REESS,CSS_M} + \Delta E_{REESS,CSS_E}$$

where:

$\Delta E_{REESS,DS_1}$ is the electric energy change of all REESSs during DS_1 of the shortened test procedure, Wh;

$\Delta E_{REESS,DS_2}$ is the electric energy change of all REESSs during DS_2 of the shortened test procedure, Wh;

$\Delta E_{REESS,CSS_M}$ is the electric energy change of all REESSs during CSS_M of the shortened test procedure, Wh;

$\Delta E_{REESS,CSS_E}$ is the electric energy change of all REESSs during CSS_E of the shortened test procedure, Wh;

and

$$EC_{DC} = \sum_{j=1}^{2} EC_{DC,j} \times k_j$$

where:

$EC_{DC,j}$ is the electric energy consumption of DS_j of the shortened test procedure according to paragraph 5.2.5.1. of this annex, Wh/km;

k_j is the weighting factor of DS_j of the shortened test procedure;

and

$$k_1 = \frac{\Delta E_{REESS,DS_1}}{UBE_{STP}} \quad \text{and} \quad k_2 = 1 - k_1$$

where:

k_1 is the weighting factor of DS_1 of the shortened test procedure;

k_2 is the weighting factor of DS_2 of the shortened test procedure;

$\Delta E_{REESS,DS_1}$ is the electric energy change of all REESSs during DS_1 of the shortened test procedure, Wh;

5.2.5.3. Calculation of electric energy consumption

The electric energy consumption based on the recharged electric energy from the mains and the pure electric range shall be calculated using the following equation:

$$C = \frac{E_{AC}}{D_e}$$

where:

C the electric energy consumption rounded to the nearest whole number based on the recharged electric energy from the mains and the non-rounded pure electric range, Wh/km;

E_{AC} is the recharged electric energy from the mains according to paragraph 5.2.4. of this annex, Wh;

D_e is the non-rounded pure electric range as calculated according to paragraph 5.2.5.2.1. or paragraph 5.2.5.2.2. of this annex, depending on the PEV test procedure that must be used according to paragraph 1.1. of this annex, km.

Annex 7 - Appendix 1

Determination of the total road load power of a vehicle powered by an electric power train only, and calibration of the dynamometer

1. Introduction

The purpose of this appendix is to define the method of measuring the total road load power of a vehicle with a statistical accuracy of ±4 per cent at a constant speed and to reproduce this measured road load power on a dynamometer with an accuracy of ±5 per cent.

As an alternative at the choice of the manufacturer, the road load may be determined according to the process described in Appendix 7 to Annex 4a of the latest version of UN Regulation No. 83 at the time of approval.

2. Characteristics of the track

The test road layout shall be level, straight and free of obstacles or wind barriers which adversely affect the variability of road load measurement.

The test road longitudinal slope shall not exceed ±2 per cent. This slope is defined as the ratio of the difference in elevation between both ends of the test road and its overall length. In addition, the local inclination between any two points 3 m apart shall not deviate by more than ±0.5 per cent from this longitudinal slope.

The maximum cross-sectional camber of the test road shall be 1.5 per cent or less.

3. Atmospheric conditions

3.1. Wind

Testing shall be performed at wind speeds averaging less than 3 m/s with peak speeds less than 5 m/s. In addition, the vector component of the wind speed across the test track must be less than 2 m/s. Wind velocity shall be measured at 0.7 m above the track surface.

3.2. Humidity

The track shall be dry.

3.3. Reference conditions

Barometric pressure $H_0 = 100$ kPa

Temperature $T_0 = 293$ K (20 °C)

Air density $d_0 = 1.189$ kg/m^3

3.3.1. Air density

3.3.1.1. The air density during the test, calculated as described in paragraph 3.3.1.2. below, shall not differ by more than 7.5 per cent from the air density under the reference conditions.

3.3.1.2. The air density shall be calculated by the formula:

$$d_T = d_0 \cdot \frac{H_T}{H_0} \cdot \frac{T_0}{T_T}$$

Where:

d_T is the air density during the test (kg/m^3)

d_0 is the air density at reference conditions (kg/m^3)

H_T is the total barometric pressure during the test (kPa)

T_T is absolute temperature during the test (K).

3.3.2. Ambient conditions

3.3.2.1. The ambient temperature shall be between 5 °C (278 K) and 35 °C (308 K) and the barometric pressure between 91 kPa and 104 kPa. The relative humidity shall be less than 95 per cent.

3.3.2.2. However, with the manufacturer's agreement, the tests may be made at lower ambient temperatures down to 1 °C. In this case the correction factor calculated for 5 °C should be used.

4. Preparation of the vehicle

4.1. Running-in

The vehicle shall be in normal running order and adjustment after having been run in for at least 300 km. The tyres shall be run in at the same time as the vehicle or shall have a tread depth within 90 and 50 per cent of the initial tread depth.

4.2. Checks

The following checks shall be made in accordance with the manufacturer's specifications for the use considered: wheels, wheel rims, tyres (make, type, pressure), front axle geometry, brake adjustment (elimination of parasitic drag), lubrication of front and rear axles, adjustment of the suspension and vehicle ground clearance, etc. Check that during freewheeling, there is no electrical braking.

4.3. Preparation for the test

4.3.1. The vehicle shall be loaded to its test mass including driver and measurement equipments, spread in a uniform way in the loading areas.

4.3.2. The windows of the vehicle shall be closed. Any covers for air conditioning systems, headlamps, etc. shall be closed.

4.3.3. The vehicle shall be clean.

4.3.4. Immediately before the test, the vehicle shall be brought to the normal running temperature in an appropriate manner.

5. Specified speed V

The specified speed is required for determining the running resistance at the reference speed from the running resistance curve. To determine the running resistance as a function of vehicle speed in the vicinity of the reference speed V_o, running resistances shall be measured at the specified speed V. At least

four to five points indicating the specified speeds, along with the reference speeds, are desired to be measured.

Table 1 shows the specified speeds in accordance with the category of the vehicle. The asterisk * indicates the reference speed in the table.

Table 1

Category *V max.*	*Specified speeds (km/h)*					
> 130	120**	100	80*	60	40	20
130 – 100	90	80*	60	40	20	-
100 – 70	60	50*	40	30	20	-
< 70	50**	40*	30	20	-	-
* Reference speed ** If it could be reached by the vehicle.						

6. Energy variation during coast-down

6.1. Total road load power determination

6.1.1. Measurement equipment and accuracy

The margin of measurement error shall be less than 0.1 second for time and less than ±0.5 km/h for speed.

6.1.2. Test procedure

6.1.2.1. Accelerate the vehicle to a speed of 5 km/h greater than the speed at which test measurement begins.

6.1.2.2. Put the gearbox to neutral, or disconnect the power supply.

6.1.2.3. Measure the time t_1 taken by the vehicle to decelerate from:

V2 = V + Δ Vkm/h to V1 = V - Δ Vkm/h

Where:

Δ V < 5 km/h for nominal speed < 50 km/h

Δ V < 10 km/h for nominal speed > 50 km/h

6.1.2.4. Carry out the same test in the opposite direction, measuring time t_2.

6.1.2.5. Take the average T1 of the two times t_1 and t_2.

6.1.2.6. Repeat these tests until the statistical accuracy (p) of the average

Ti

is equal to or less than 4 per cent (p < 4 per cent).

The statistical accuracy (p) is defined by:

$$p = \frac{t.s}{\sqrt{n}} \cdot \frac{100}{T}$$

Where:

T is the coefficient given by the table below

s is the standard deviation: $s = \sqrt{\sum_{i=1}^{n} \frac{(Ti-T)^2}{n-1}}$

n is the number of tests

n	*4*	*5*	*6*	*7*	*8*	*9*	*10*
t	3.2	2.8	2.6	2.5	2.4	2.3	2.3
t/√n	1.6.	1.25	1.06	0.94	0.85	0.77	0.73

6.1.2.7. Calculation of the running resistance force

The running resistance force F at the specified speed V is calculated as follows:

$$F = (M_{HP} + M_r) \cdot \frac{2\Delta V}{\Delta T} \cdot \frac{1}{3.6} \quad [N]$$

Where:

M_{HP} is the test mass

M_r is the equivalent inertia mass of all the wheels and vehicle portions rotating with the wheels during coast down on the road. M_r should be measured or calculated by an appropriate manner.

6.1.2.8. The running resistance determined on the track shall be corrected to the reference ambient conditions as follows:

F corrected = k · F measured

$$k = \frac{R_R}{R_T}\left[1 + K_R (t - t_0)\right] + \frac{R_{AERO}}{R_T}\frac{d_0}{d_t}$$

Where:

R_R is the rolling resistance at speed V

R_{AERO} is the aerodynamic drag at speed V

R_T is the total road load = R_R+R_{AERO}

K_R is the temperature correction factor of rolling resistance, taken to be equal to: 3.6 x 10^{-3}/°C

t is the road test ambient temperature in °C

t_0 is the reference ambient temperature = 20 °C

d_t is the air density at the test conditions

d_0 is the air density at the reference conditions

(20 °C, 100 kPa) = 1.189 kg/m3.

The ratios R_R/R_T and R_{AERO}/R_T shall be specified by the vehicle manufacturer on the basis of the data normally available to the company.

If these values are not available, subject to the agreement of the manufacturer and the Technical Service concerned, the figures for the rolling/total resistance ratio given by the following formula may be used:

$$\frac{R_R}{R_T} = aM_{HP} + b$$

Where:

M_{HP} is the test mass

and for each speed the coefficients a and b are as shown in the following table:

V (km/h)	*a*	*b*
20	$7.24 \cdot 10^{-5}$	0.82
40	$1.59 \cdot 10^{-4}$	0.54
60	$1.96 \cdot 10^{-4}$	0.33
80	$1.85 \cdot 10^{-4}$	0.23
100	$1.63 \cdot 10^{-4}$	0.18
120	$1.57 \cdot 10^{-4}$	0.14

6.2. Setting of the dynamometer

The purpose of this procedure is to simulate on the dynamometer the total road load power at a given speed.

6.2.1. Measurement equipment and accuracy

The measuring equipment shall be similar to that used on the track.

6.2.2. Test procedure

6.2.2.1. Install the vehicle on the dynamometer.

6.2.2.2. Adjust the tyre pressure (cold) of the driving wheels as required for the chassis dynamometer.

6.2.2.3. Adjust the equivalent inertia mass of the chassis dynamometer, according to Table 2.

Table 2

Test mass M_{HP} *(kg)*	*Equivalent inertia I (kg)*
$M_{HP} \leq 480$	455
$480 < M_{HP} \leq 540$	510
$540 < M_{HP} \leq 595$	570
$595 < M_{HP} \leq 650$	625
$650 < M_{HP} \leq 710$	680
$710 < M_{HP} \leq 765$	740
$765 < M_{HP} \leq 850$	800
$850 < M_{HP} \leq 965$	910
$965 < M_{HP} \leq 1{,}080$	1,020
$1{,}080 < M_{HP} \leq 1{,}190$	1,130
$1{,}190 < M_{HP} \leq 1{,}305$	1,250
$1{,}305 < M_{HP} \leq 1{,}420$	1,360
$1{,}420 < M_{HP} \leq 1{,}530$	1,470
$1{,}530 < M_{HP} \leq 1{,}640$	1,590
$1{,}640 < M_{HP} \leq 1{,}760$	1,700

Test mass M_{HP} *(kg)*	*Equivalent inertia* I *(kg)*
$1{,}760 < M_{HP} \leq 1{,}870$	1,810
$1{,}870 < M_{HP} \leq 1{,}980$	1,930
$1{,}980 < M_{HP} \leq 2{,}100$	2,040
$2{,}100 < M_{HP} \leq 2{,}210$	2,150
$2{,}210 < M_{HP} \leq 2{,}380$	2,270
$2{,}380 < M_{HP} \leq 2{,}610$	2,270
$2{,}610 < M_{HP}$	2,270

6.2.2.4. Bring the vehicle and the chassis dynamometer to the stabilized operating temperature, in order to approximate the road conditions.

6.2.2.5. Carry out the operations specified in paragraph 6.1.2. of this annex with the exception of paragraphs 6.1.2.4. and 6.1.2.5., replacing M_{HP} by I and M_r by M_{rm} in the formula given in paragraph 6.1.2.7.

6.2.2.6. Adjust the brake to reproduce the corrected running resistance half payload (paragraph 6.1.2.8. of this annex) and to take into account the difference between the vehicle mass on the track and the equivalent inertia test mass (I) to be used. This may be done by calculating the mean corrected road coast down time from V_2 to V_1 and reproducing the same time on the dynamometer by the following relationship:

$$T_{corrected} = (I + M_{rm}) \frac{2\Delta V}{F_{corrected}} \cdot \frac{1}{3.6}$$

Where:

I is the flywheel equivalent inertia mass of chassis dynamometer.

M_{rm} is the equivalent inertia mass of the powered wheels and vehicle portions rotating with the wheels during coast down. M_{rm} shall be measured or calculated by an appropriate manner.

6.2.2.7. The power P_a to be absorbed by the bench should be determined in order to enable the same total road load power to be reproduced for the same vehicle on different days or on different chassis dynamometers of the same type.

Annex 7 - Appendix 2

Alternative procedure for determination of the total road load power of a vehicle

1. Introduction

The purpose of this appendix is to provide the road load power calculation method that may be used, at the choice of manufacturer, when the vehicle road load has been determined according to WLTP procedures as defined in UN GTR No. 15.

2. Method

2.1. WLTP Road Load calculation of the vehicle

The WLTP Road Load of the vehicle shall be determined according to UN GTR No. 15 Annex 4 or in case the vehicle is part of an interpolation family, according to Annex 7 point 3.2.3.2.2. "Road Load calculation for an individual vehicle" considering as input parameters of the individual vehicle:

(a) The Test Mass of the vehicle,[1] fitted with its standard equipment;

(b) The RRC value of the applicable tyre energy class according to Table A4/2 of UN GTR No. 15 Annex 4 or, if the tyres on the front and rear axles belong to different energy efficiency classes, the weighted mean using the equation in paragraph 3.2.3.2.2.2.3. of Annex 7 to UN GTR No. 15;

(c) The aerodynamic drag of the vehicle fitted with its standard equipment.

2.2. Calculation of the applicable (NEDC) road load of the vehicle

2.2.1. Effect of different tyre pressure prescriptions

The tyre pressure to be taken into account for the purpose of calculating the NEDC road load shall be the average between the two axles of the average between the minimum and maximum tyre pressure permitted for the selected tyres on each axle for the NEDC reference mass of the vehicle. The calculation shall be carried out with the following formula:

$$P_{avg} = \left(\frac{P_{max} + P_{min}}{2}\right)$$

Where,

P_{max}, is the average of the maximum tyre pressures of the selected tyres for the two axles;

P_{min}, is the average of the minimum tyre pressures of the selected tyres for the two axles.

The corresponding effect in terms of resistance applied to the vehicle shall be calculated using the following formula:

$$TP = \left(\frac{P_{avg}}{P_{min}}\right)^{-0.4}$$

As defined in UN GTR No. 15

2.2.2. Effect of tyre tread depth

The effect in terms of the resistance applied to the vehicle shall be determined in accordance with the following formula:

$$TTD = \left(2 \cdot \frac{0.1 \cdot RM_n \cdot 9.81}{1000}\right)$$

Where, RM_n is the reference mass of the vehicle according to this Regulation

2.2.3. Effect of different consideration of rotating parts

During the WLTP coastdown setting, coastdown times are to be transferred to forces and vice versa by taking into account the applicable test mass plus the effect of rotational mass (3 % of the sum of the MRO and 25 kg). For the NEDC coastdown setting, coastdown times are to be transferred to forces and vice versa by neglecting the effect of rotational mass.

2.2.4. Determination of the NEDC road load coefficients

(a) The road load coefficient $F_{0,n}$ expressed in Newton (N) for vehicle shall be determined as follows:

(i) Effect of different inertia:

$$F_{0n}^1 = F_{0w} \cdot \left(\frac{RM_n}{TM_w}\right)$$

Where:

RM_n is the Reference Mass of the vehicle according to this Regulation

F_{0w} is the road load coefficient F_0 determined for the WLTP test of the vehicle;

TM_w is the WLTP test mass of the vehicle fitted with its standard equipment.

(ii) Effect of different tyre pressure:

$$F_{0n}^2 = F_{0n}^1 \cdot TP$$

Where the factors TP in the formula are as defined in point 2.2.1.

(iii) Effect of the inertia of rotating parts:

$$F_{0n}^3 = F_{0n}^2 \cdot \left(\frac{1}{1.03}\right)$$

(iv) Effect of different tyre tread depth:

$$F_{0n} = F_{0n}^3 - TTD$$

Where the factors TTD in the formula are as defined in point 2.2.2

(b) The road load coefficient F_{1n} for the vehicle shall be determined as follows:

$$F_{1n} = F_{1w} \cdot \left(\frac{1}{1.03}\right)$$

(c) The road load coefficient F_{2n} for the vehicle shall be determined as follows:

$$F_{2n} = F_{2w} \cdot \left(\frac{1}{1.03}\right)$$

Where the factor F_{2w} is the WLTP road load coefficient F_2 determined of the vehicle fitted with its standard equipment.

Annex 7 - Appendix 3

Determination of REESS current and REESS voltage of PEVs

1. Introduction

1.1. This Appendix defines the method and required instrumentation to determine the REESS current and the REESS voltage of PEVs.

1.2. Measurement of REESS current and REESS voltage shall start at the same time as the test starts and shall end immediately after the vehicle has finished the test.

1.3. A list of the instrumentation used by the manufacturer to measure REESS voltage and current (including instrument manufacturer, model number, serial number, last calibration dates (where applicable)) shall be provided to the approval authority.

2. REESS current

REESS depletion is considered as a negative current.

2.1. External REESS current measurement

2.1.1. The REESS current(s) shall be measured during the tests using a clamp- on or closed type current transducer. The current measurement system shall fulfil the requirements specified in paragraph 1.2. of this annex. The current transducer(s) shall be capable of handling the peak currents and temperature conditions at the point of measurement.

In order to have an accurate measurement, zero adjustment and degaussing shall be performed before the test in accordance with the instrument manufacturer's instructions.

2.1.2. Current transducers shall be fitted to any of the REESS on one of the cables connected directly to the REESS and shall include the total REESS current.

In case of shielded wires, appropriate methods shall be applied in accordance with the approval authority.

In order to easily measure the REESS current using external measuring equipment, the manufacturer should provide appropriate, safe and accessible connection points in the vehicle. If that is not feasible, the manufacturer is obliged to support the approval authority in connecting a current transducer to one of the cables directly connected to the REESS in the manner described above in this paragraph.

2.1.3. The current transducer output shall be sampled with a minimum frequency of 20 Hz. The measured current shall be integrated over time, yielding the measured value of Q, expressed in ampere-hours Ah. The integration may be done in the current measurement system.

2.2. Vehicle on-board REESS current data

As an alternative to paragraph 2.1. of this appendix, the manufacturer may use the on-board current measurement data. The accuracy of these data shall be demonstrated to the approval authority.

3. REESS voltage

3.1. External REESS voltage measurement

The REESS voltage(s) shall be measured during the tests. The voltage measurement equipment shall fulfil the requirements specified in paragraph 1.2. of this annex. To measure the REESS voltage using external measuring equipment, the manufacturers shall support the approval authority by providing REESS voltage measurement points.

3.2. Vehicle on-board REESS voltage data

As an alternative to paragraph 3.1. of this appendix, the manufacturer may use the on-board voltage measurement data. The accuracy of these data shall be demonstrated to the approval authority.

Annex 8

Method of measuring the emissions of carbon dioxide, fuel consumption and the electric energy consumption of vehicles powered by a hybrid electric power train

1. Introduction

1.1. This annex defines the specific provisions regarding type-approval of a hybrid electric vehicle (HEV) as defined in paragraph 2.17.1. of this Regulation.

1.2. As a general principle for the tests, hybrid electric vehicles shall be tested according to the principles applied to vehicles powered by an internal combustion engine only (Annex 6), unless modified by this annex.

1.3. OVC vehicles (as categorised in paragraph 2. of this annex) shall be tested according to condition A and to condition B.

The test results under both conditions A and B and the weighted average shall be reported in the communication form described in Annex 4.

1.4. Driving cycles and gear shifting points

1.4.1. For vehicles with a manual transmission the driving cycle described in paragraph 6.1. of Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle shall be used, including the prescribed gear shifting points.

1.4.2. For vehicles with a special gear shifting strategy the gear shifting points prescribed in paragraph 6.1. of Annex 4a to Regulation No. 83 are not applied. For these vehicles the driving cycle specified in paragraph 6.1.3.2. of Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle shall be used. Concerning gear shifting points, these vehicles shall be driven according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers information).

1.4.3. For vehicles with an automatic transmission the driving cycle specified in paragraph 6.1.3.2. of Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle shall be used.

1.4.4. For vehicle conditioning a combination of the Part One and/or Part Two cycles of the applicable driving cycle shall be used as prescribed in this annex.

2. Categories of hybrid electric vehicles

Vehicle charging	*Off-Vehicle Charging*[(a)] *(OVC)*		*Not Off-Vehicle Charging*[(b)] *(NOVC)*	
Operating mode switch	Without	With	Without	With

(a) Also known as "externally chargeable"
(b) Also known as "not externally chargeable"

3. Externally chargeable (OVC electric HEV) without an operating mode switch

3.1. Two tests shall be performed under the following conditions:

Condition A: Test shall be started with a fully charged electrical energy/power storage device.

Condition B: Test shall be started with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

The profile of the State of Charge (SOC) of the electrical energy/power storage device during different stages of the Type I test is given in Appendix 1 to this annex.

3.2. Condition A

3.2.1. The procedure shall start with the discharge of the electrical energy/power storage device as described in paragraph 3.2.1.1. below:

3.2.1.1. Discharge of the electrical energy/power storage device

The electrical energy/power storage device of the vehicle is discharged while driving (on the test track, on a chassis dynamometer, etc.):

(a) At a steady speed of 50 km/h until the fuel consuming engine of the HEV starts up;

(b) Or, if a vehicle cannot reach a steady speed of 50 km/h without starting up the fuel consuming engine, the speed shall be reduced until the vehicle can run a lower steady speed where the fuel consuming engine just does not start up for a defined time/distance (to be specified between technical service and manufacturer);

(c) Or with manufacturer's recommendation.

The fuel consuming engine shall be stopped within ten seconds of it being automatically started.

3.2.2. Conditioning of the vehicle

3.2.2.1. For conditioning compression-ignition engined vehicles the Part Two cycle of the applicable driving cycle shall be used in combination with the applicable gear shifting prescriptions as defined in paragraph 1.4. of this annex. Three consecutive cycles shall be driven.

3.2.2.2. Vehicles fitted with positive-ignition engines shall be preconditioned with one Part One and two Part Two cycles of the applicable driving cycle in combination with the applicable gear shifting prescriptions as defined in paragraph 1.4. of this annex.

3.2.2.3. After this preconditioning, and before testing, the vehicle shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 °C and 30 °C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within +/-2 K of the temperature of the room, and the electrical energy/power storage device is fully charged as a result of the charging prescribed in paragraph 3.2.2.4. below.

3.2.2.4. During soak, the electrical energy/power storage device shall be charged, using the normal overnight charging procedure as defined in paragraph 3.2.2.5. below.

3.2.2.5. Application of a normal overnight charge

The electrical energy/power storage device shall be charged according to the following procedure.

3.2.2.5.1. Normal overnight charge procedure

The charging is carried out:

(a) With the on board charger if fitted; or

(b) With an external charger recommended by the manufacturer using the charging pattern prescribed for normal charging;

(c) In an ambient temperature comprised between 20 °C and 30 °C. This procedure excludes all types of special charges that could be automatically or manually initiated like, for instance, the equalisation charges or the servicing charges. The manufacturer shall declare that during the test, a special charge procedure has not occurred.

3.2.2.5.2. End of charge criteria

The end of charge criteria corresponds to a charging time of twelve hours, except if a clear indication is given to the driver by the standard instrumentation that the electrical energy/power storage device is not yet fully charged.

In this case,

$$the\ maximum\ time\ is\ = \frac{3 \cdot claimed\ battery\ capacity\ (Wh)}{mains\ power\ supply\ (W)}$$

3.2.3. Test procedure

3.2.3.1. The vehicle shall be started up by the means provided for normal use to the driver. The first cycle starts on the initiation of the vehicle start-up procedure.

3.2.3.2. The test procedures defined in either paragraph 3.2.3.2.1. or 3.2.3.2.2. below may be used.

3.2.3.2.1. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and end on conclusion of the final idling period in the extra-urban cycle (Part Two, end of sampling (ES)).

3.2.3.2.2. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and continue over a number of repeat test cycles. It shall end on conclusion of the final idling period in the first extra-urban (Part Two) cycle during which the battery reached the minimum state of charge according to the criterion defined below (end of sampling (ES)).

The electricity balance Q (Ah) is measured over each combined cycle, using the procedure specified in Appendix 2 to this annex, and used to determine when the battery minimum state of charge has been reached.

The battery minimum state of charge is considered to have been reached in combined cycle N if the electricity balance measured during combined cycle N+1 is not more than a 3 per cent discharge, expressed as a percentage of the nominal capacity of the battery (in Ah) in its maximum state of charge, as declared by the manufacturer. At the manufacturer's request additional test cycles may be run and their results included in the calculations in paragraphs 3.2.3.5. and 3.4.1. below provided that the electricity balance for

each additional test cycle shows less discharge of the battery than over the previous cycle.

In between each of the cycles a hot soak period of up to ten minutes is allowed. The powertrain shall be switched off during this period.

3.2.3.3. The vehicle shall be driven using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

3.2.3.4. The exhaust gases shall be analysed according to Annex 4a of Regulation No. 83 in force at the time of approval of the vehicle.

3.2.3.5. The test results on the combined cycle (CO_2 and fuel consumption) for condition A shall be recorded (respectively m_1 (g) and c_1 (l)). In the case of testing according to paragraph 3.2.3.2.1. of this annex, m_1 and c_1 are simply the results of the single combined cycle run. In the case of testing according to paragraph 3.2.3.2.2. of this annex, m_1 and c_1 are the sums of the results of the N combined cycles run.

$$m_1 = \sum_1^N m_i \quad c_1 = \sum_1^N c_i$$

3.2.4. Within the 30 minutes after the conclusion of the last cycle, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex). The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e1 (Wh) delivered from the mains.

3.2.5. The electric energy consumption for condition A is e_1 (Wh).

3.3. Condition B

3.3.1. Conditioning of the vehicle

3.3.1.1. The electrical energy/power storage device of the vehicle shall be discharged according to paragraph 3.2.1.1. of this annex. At the manufacturer's request, a conditioning according to paragraph 3.2.2.1. or 3.2.2.2. of this annex may be carried out before electrical energy / power storage discharge.

3.3.1.2. Before testing, the vehicle shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 °C and 30 °C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within +/-2 K of the temperature of the room.

3.3.2. Test procedure

3.3.2.1. The vehicle shall be started up by the means provided for normal use to the driver. The first cycle starts on the initiation of the vehicle start-up procedure.

3.3.2.2. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and end on conclusion of the final idling period in the extra-urban cycle (Part Two, end of sampling (ES)).

3.3.2.3. The vehicle shall be driven using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

3.3.2.4. The exhaust gases shall be analysed according to Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle.

3.3.2.5. The test results on the combined cycle (CO_2 and fuel consumption) for Condition B shall be recorded (respectively m_2 (g) and c_2 (l)).

3.3.3. Within the 30 minutes after the conclusion of the cycle, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex.

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e_2 (Wh) delivered from the mains.

3.3.4. The electrical energy/power storage device of the vehicle shall be discharged according to paragraph 3.2.1.1. of this annex.

3.3.5. Within 30 minutes after the discharge, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex.

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e_3 (Wh) delivered from the mains.

3.3.6. The electric energy consumption e_4 (Wh) for condition B is: $e_4 = e_2 - e_3$

3.4. Test results

3.4.1. The values of CO_2 shall be $M_1 = m_1/Dtest_1$ and $M_2 = m_2/Dtest_2$ (g/km) with $Dtest_1$ and $Dtest_2$ the total actual driven distances in the tests performed under conditions A (paragraph 3.2.of this annex) and B (paragraph 3.3. of this annex) respectively, and m_1 and m_2 determined in paragraphs 3.2.3.5. and 3.3.2.5. of this annex respectively.

3.4.2. The weighted values of CO_2 shall be calculated as below:

3.4.2.1. In the case of testing according to paragraph 3.2.3.2.1.:

$$M = (D_e \cdot M_1 + D_{av} \cdot M_2)/(D_e + D_{av})$$

Where:

M = mass emission of CO_2 in grams per kilometre.

M_1 = mass emission of CO_2 in grams per kilometre with a fully charged electrical energy/power storage device.

M_2 = mass emission of CO_2 in grams per kilometre with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_e = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

3.4.2.2. In the case of testing according to paragraph 3.2.3.2.2.:

$$M = (D_{ovc} \cdot M_1 + D_{av} \cdot M_2)/(D_{ovc} + D_{av})$$

Where:

M = mass emission of CO_2 in grams per kilometre.

M_1 = mass emission of CO_2 in grams per kilometre with a fully charged electrical energy/power storage device.

M_2 = mass emission of CO2 in grams per kilometre with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to this Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

3.4.3. The values of fuel consumption shall be

$C_1 = 100 \cdot c_1/D_{test1}$ and $C_2 = 100 \cdot c_2/D_{test2}$ (l/100 km)

With D_{test1} and D_{test2} the total actual driven distances in the tests performed under conditions A (paragraph 3.2. of this annex) and B (paragraph 3.3. of this annex) respectively, and c_1 and c_2 determined in paragraphs 3.2.3.5. and 3.3.2.5. of this annex respectively.

3.4.4. The weighted values of fuel consumption shall be calculated as below:

3.4.4.1. In the case of test procedure according to paragraph 3.2.3.2.1. of this annex:

$C = (D_e \cdot C_1 + D_{av} \cdot C_2)/(D_e + D_{av})$

Where:

C = fuel consumption in l/100 km.

C_1 = fuel consumption in l/100 km with a fully charged electrical energy/power storage device.

C_2 = fuel consumption in l/100 km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_e = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

3.4.4.2. In the case of testing according to paragraph 3.2.3.2.2. of this annex:

$C = (D_{ovc} \cdot C_1 + D_{av} \cdot C_2)/(D_{ovc} + D_{av})$

Where:

C = fuel consumption in l/100 km.

C_1 = fuel consumption in l/100 km with a fully charged electrical energy/power storage device.

C_2 = fuel consumption in l/100 km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to this Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

3.4.5. The values of electric energy consumption shall be:

$E_1 = e_1/D_{test1}$ and $E_4 = e_4/D_{test2}$ (Wh/km)

with D_{test1} and D_{test2} the total actual driven distances in the tests performed under conditions A (paragraph 3.2. of this annex) and B (paragraph 3.3. of this annex) respectively, and e_1 and e_4 determined in paragraphs 3.2.5. and 3.3.6. of this annex respectively.

3.4.6. The weighted values of electric energy consumption shall be calculated as below:

3.4.6.1. In the case of testing according to paragraph 3.2.3.2.1. of this annex:

$E = (D_e \cdot E_1 + D_{av} \cdot E_4) / (D_e + D_{av})$

where:

E = electric consumption Wh/km.

E_1 = electric consumption Wh/km with a fully charged electrical energy/power storage device calculated.

E_4 = electric consumption Wh/km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_e = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

3.4.6.2. In the case of testing according to paragraph 3.2.3.2.2. of this annex:

$E = (D_{ovc} \cdot E_1 + D_{av} \cdot E_4) / (D_{ovc} + D_{av})$

Where:

E = electric consumption Wh/km.

E_1 = electric consumption Wh/km with a fully charged electrical energy/power storage device calculated.

E_4 = electric consumption Wh/km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to this Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

4. Externally chargeable (OVC HEV) with an operating mode switch

4.1. Two tests shall be performed under the following conditions:

4.1.1. Condition A: Test shall be started with a fully charged electrical energy/power storage device.

4.1.2. Condition B: Test shall be started with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity) and carried out with an operating mode keeping the vehicle in charge-sustaining operating condition, that being an operating condition in which the

energy/power stored in the energy/power storage device may fluctuate but, on average, is maintained at a neutral charging balance level while the vehicle is driven.

4.1.3. In agreement with the type approval authority and justified by the manufacturer, the following operation modes shall not be considered for the purpose of testing:

(a) Operating modes, such as 'charge mode', which are not limited to vehicle propulsion but which, in addition to vehicle propulsion, are charging the energy power/storage device in order to facilitate locally emission-free driving (e.g. under urban conditions);

(b) Operating modes for vehicle maintenance, such as 'maintenance mode';

(c) Operating modes for special limited purposes and not intended for daily operation, such as 'mountain mode'.

4.1.4. The operating mode shall be selected as described in paragraphs 4.1.4.1. to 4.1.4.2.2. inclusive.

4.1.4.1. Operating mode selection for Condition A

4.1.4.1.1. If there is a single operating mode under condition A that is always selected when the vehicle is switched on regardless of the operating mode selected when the vehicle was previously shut down, and which cannot be switched to another mode without an intentional action of the driver or be redefined, this single operating mode shall be selected.

4.1.4.1.2. If there is no single operating mode under condition A that is always selected when the vehicle is switched on, the most electric energy consuming mode shall be selected.

4.1.4.2. Operating mode selection for Condition B

4.1.4.2.1. If there is a single operating mode under condition B that is always selected when the vehicle is switched on regardless of the operating mode selected when the vehicle was previously shut down, and which cannot be switched to another mode without an intentional action of the driver or be redefined, this single operating mode shall be selected.

4.1.4.2.2. If there is no single operating mode under condition B that is always selected when the vehicle is switched on, the most fuel consuming mode shall be selected.4.2. Condition A

4.2.1. If the electric range of the vehicle, as measured in accordance with Annex 9 to this Regulation, is higher than 1 complete cycle, on the request of the manufacturer, the type I test for electric energy measurement may be carried out in pure electric mode, after agreement of the Technical Service. In this case, the values of M_1 and C_1 in paragraph 4.4. below are equal to 0.

4.2.2. The procedure shall start with the discharge of the electrical energy/power storage device of the vehicle as described in paragraph 4.2.2.1. below.

4.2.2.1. The electrical energy/power storage device of the vehicle is discharged while driving with the switch in pure electric position (on the test track, on a chassis dynamometer, etc.) at a steady speed of 70 per cent ± 5 per cent of the maximum thirty minutes speed of the vehicle in pure electric mode, which is

to be determined according to the test procedure for electric vehicles defined in UN Regulation No. 68.

Stopping the discharge occurs:

(a) When the vehicle is not able to run at 65 per cent of the maximum thirty minutes speed; or

(b) When an indication to stop the vehicle is given to the driver by the standard on-board instrumentation; or

(c) After covering a distance of 100 km.

If the vehicle is not equipped with a pure electric mode, the electrical energy/power storage device discharge shall be achieved by driving the vehicle (on the test track, on a chassis dynamometer, etc.):

(a) At a steady speed of 50 km/h until the fuel consuming engine of the HEV starts up;

(b) Or if a vehicle cannot reach a steady speed of 50 km/h without starting up the fuel consuming engine, the speed shall be reduced until the vehicle can run a lower steady speed where the fuel consuming engine just does not start up for a defined time/distance (to be specified between technical service and manufacturer);

(c) Or with manufacturer's recommendation.

The fuel-consuming engine shall be stopped within 10 seconds of it being automatically started.

4.2.3. Conditioning of the vehicle:

4.2.3.1. For conditioning compression-ignition engined vehicles the Part Two cycle of the applicable driving cycle shall be used in combination with the applicable gear shifting prescriptions as defined in paragraph 1.4. of this annex. Three consecutive cycles shall be driven.

4.2.3.2. Vehicles fitted with positive-ignition engines shall be preconditioned with one Part One and two Part Two cycles of the applicable driving cycle in combination with the applicable gear shifting prescriptions as defined in paragraph 1.4. of this annex.

4.2.3.3. After this preconditioning, and before testing, the vehicle shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 °C and 30 °C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within ±2 K of the temperature of the room, and the electrical energy/power storage device is fully charged as a result of the charging prescribed in paragraph 4.2.3.4. below.

4.2.3.4. During soak, the electrical energy/power storage device shall be charged, using the normal overnight charging procedure as defined in paragraph 3.2.2.5. of this annex.

4.2.4. Test procedure

4.2.4.1. The vehicle shall be started up by the means provided for normal use to the driver. The first cycle starts on the initiation of the vehicle start-up procedure.

4.2.4.2. The test procedures defined in either paragraph 4.2.4.2.1. or 4.2.4.2.2. below may be used.

4.2.4.2.1. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and end on conclusion of the final idling period in the extra-urban cycle (Part Two, end of sampling (ES)).

4.2.4.2.2. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and continue over a number of repeat test cycles. It shall end on conclusion of the final idling period in the first extra-urban (Part Two) cycle during which the battery reached the minimum state of charge according to the criterion defined below (end of sampling (ES)).

The electricity balance Q (Ah) is measured over each combined cycle, using the procedure specified in Appendix 2 to this annex, and used to determine when the battery minimum state of charge has been reached.

The battery minimum state of charge is considered to have been reached in combined cycle N if the electricity balance measured during combined cycle N+1 is not more than a 3 per cent discharge, expressed as a percentage of the nominal capacity of the battery (in Ah) in its maximum state of charge, as declared by the manufacturer. At the manufacturer's request additional test cycles may be run and their results included in the calculations in paragraphs 4.2.4.5. and 4.4.1. below provided that the electricity balance for each additional test cycle shows less discharge of the battery than over the previous cycle.

In between each of the cycles a hot soak period of up to ten minutes is allowed. The powertrain shall be switched off during this period.

4.2.4.3. The vehicle shall be driven using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. to this annex.

4.2.4.4. The exhaust gases shall be analysed according to Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle.

4.2.4.5. The test results on the combined cycle (CO_2 and fuel consumption) for Condition A shall be recorded (respectively m_1 (g) and c_1 (l)). In the case of testing according to paragraph 4.2.4.2.1. of this annex, m_1 and c_1 are simply the results of the single combined cycle run. In the case of testing according to paragraph 4.2.4.2.2. of this annex, m_1 and c_1 are the sums of the results of the N combined cycles run.

$$m_1 = \sum_1^N m_i \qquad c_1 = \sum_1^N c_i$$

4.2.5. Within the 30 minutes after the conclusion of the last cycle, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex).

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e_1 (Wh) delivered from the mains.

4.2.6. The electric energy consumption for condition A is e_1 (Wh).

4.3. Condition B

4.3.1. Conditioning of the vehicle

4.3.1.1. The electrical energy/power storage device of the vehicle shall be discharged according to paragraph 4.2.2.1. of this annex.

At the manufacturer's request, a conditioning according to paragraph 4.2.3.1. or 4.2.3.2. of this annex may be carried out before electrical energy / power storage discharge.

4.3.1.2. Before testing, the vehicle shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 and 30 °C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within ±2 K of the temperature of the room.

4.3.2. Test procedure

4.3.2.1. The vehicle shall be started up by the means provided for normal use to the driver. The first cycle starts on the initiation of the vehicle start-up procedure.

4.3.2.2. Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and end on conclusion of the final idling period in the extra-urban cycle (Part Two, end of sampling (ES)).

4.3.2.3. The vehicle shall be driven using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

4.3.2.4. The exhaust gases shall be analysed according Annex 4a to Regulation No. 83 in force at the time of approval of the vehicle.

4.3.2.5. The test results on the combined cycle (CO_2 and fuel consumption) for condition B shall be recorded (respectively m_2 (g) and c_2 (l)).

4.3.3. Within the 30 minutes after the conclusion of the cycle, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex.

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e_2 (Wh) delivered from the mains.

4.3.4. The electrical energy/power storage device of the vehicle shall be discharged in accordance with paragraph 4.2.2.1. of this annex.

4.3.5. Within thirty minutes after the discharge, the electrical energy/power storage device shall be charged according to paragraph 3.2.2.5. of this annex.

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy e_3 (Wh) delivered from the mains.

4.3.6. The electric energy consumption e_4 (Wh) for condition B is: $e_4 = e_2 - e_3$

4.4. Test results

4.4.1. The values of CO_2 shall be $M_1 = m_1/Dtest_1$ and $M_2 = m_2/Dtest_2$ (g/km) with $Dtest_1$ and $Dtest_2$ the total actual driven distances in the tests performed under conditions A (paragraph 4.2. of this annex) and B (paragraph 4.3. of this annex) respectively, and m_1 and m_2 determined in paragraphs 4.2.4.5. and 4.3.2.5. of this annex respectively.

4.4.2. The weighted values of CO_2 shall be calculated as below:

4.4.2.1. In the case of testing according to paragraph 4.2.4.2.1. of this annex:

$M = (D_e \cdot M_1 + D_{av} \cdot M_2)/(D_e + D_{av})$

Where:

M = mass emission of CO_2 in grams per kilometre.

M_1 = mass emission of CO_2 in grams per kilometre with a fully charged electrical energy/power storage device.

M_2 = mass emission of CO_2 in grams per kilometre with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

De = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

4.4.2.2. In the case of testing according to paragraph 4.2.4.2.2. of this annex:

$M = (D_{ovc} \cdot M_1 + D_{av} \cdot M_2)/(D_{ovc} + D_{av})$

Where

M = mass emission of CO_2 in grams per kilometre.

M_1 = mass emission of CO_2 in grams per kilometre with a fully charged electrical energy/power storage device.

M_2 = mass emission of CO_2 in grams per kilometre with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to the Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

4.4.3. The values of fuel consumption shall be:

$C_1 = 100 \cdot c_1/D_{test1}$ and $C_2 = 100 \cdot c_2/D_{test2}$ (l/100 km)

with D_{test1} and D_{test2} the total actual driven distances in the tests performed under conditions A (paragraph 4.2. of this annex) and B (paragraph 4.3. of this annex) respectively, and c_1 and c_2 determined in paragraphs 4.2.4.5. and 4.3.2.5. of this annex respectively.

4.4.4. The weighted values of fuel consumption shall be calculated as below:

4.4.4.1. In the case of testing according to paragraph 4.2.4.2.1. of this annex:

$C = (D_e \cdot C_1 + D_{av} \cdot C_2)/(D_e + D_{av})$

Where:

C = fuel consumption in l/100 km.

C_1 = fuel consumption in l/100 km with a fully charged electrical energy/power storage device.

C_2 = fuel consumption in l/100 km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_e = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

4.4.4.2. In the case of testing according to paragraph 4.2.4.2.2. of this annex:

$C = (D_{ovc} \cdot C_1 + D_{av} \cdot C_2)/(D_{ovc} + D_{av})$

Where:

C = fuel consumption in l/100 km.

C_1 = fuel consumption in l/100 km with a fully charged electrical energy/power storage device.

C_2 = fuel consumption in l/100 km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to this Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

4.4.5. The values of electric energy consumption shall be:

$E_1 = e_1/D_{test1}$ and $E_4 = e_4/D_{test2}$ (Wh/km)

With D_{test1} and D_{test2} the total actual driven distances in the tests performed under conditions A (paragraph 4.2. of this annex) and B (paragraph 3.3. of this annex) respectively, and e_1 and e_4 determined in paragraphs 4.2.6. and 4.3.6. of this annex respectively.

4.4.6. The weighted values of electric energy consumption shall be calculated as below:

4.4.6.1. In the case of testing according to paragraph 4.2.4.2.1.:

$E = (D_e \cdot E_1 + D_{av} \cdot E_4) / (D_e + D_{av})$

Where:

E = electric consumption Wh/km.

E_1 = electric consumption Wh/km with a fully charged electrical energy/power storage device calculated.

E_4 = electric consumption Wh/km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_e = vehicle's electric range, according to the procedure described in Annex 9 to this Regulation, where the manufacturer must provide the means for performing the measurement with the vehicle running in pure electric operating state.

D_{av} = 25 km (assumed average distance between two battery recharges).

4.4.6.2. In the case of testing according to paragraph 4.2.4.2.2. of this annex:

$E = (D_{ovc} \cdot E_1 + D_{av} \cdot E_4) / (D_{ovc} + D_{av})$

Where:

E = electric consumption Wh/km.

E_1 = electric consumption Wh/km with a fully charged electrical energy/power storage device calculated.

E4 = electric consumption Wh/km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity).

D_{ovc} = OVC range according to the procedure described in Annex 9 to this Regulation.

D_{av} = 25 km (assumed average distance between two battery recharges).

5. Not externally chargeable (NOVC HEV) without an operating mode switch

5.1. These vehicles shall be tested according to Annex 6 to this Regulation, using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

5.1.1. Emissions of carbon dioxide (CO_2) and fuel consumption shall be determined separately for the Part One (urban driving) and the Part Two (extra-urban driving) of the specified driving cycle.

5.2. For preconditioning, at least 2 consecutive complete driving cycles (one Part One and one Part Two) are carried out without intermediate soak, using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

5.3. Test results

5.3.1. The test results (fuel consumption C (l/100 km) and CO_2-emission M [g/km]) of this test are corrected in function of the energy balance ΔE_{batt} of the vehicle's battery.

The corrected values (C_0 (l/100 km) and M_0 (g/km)) should correspond to a zero energy balance ($\Delta E_{batt} = 0$), and are calculated using a correction coefficient determined by the manufacturer as defined below.

In case of other storage systems than an electric battery, ΔE_{batt} is representing $\Delta E_{storage}$, the energy balance of the electric energy storage device.

5.3.1.1. The electricity balance Q (Ah), measured using the procedure specified in Appendix 2 to this annex, is used as a measure of the difference in the vehicle battery's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance is to be determined separately for the Part One cycle and the Part Two cycle.

5.3.2. Under the conditions below, it is allowed to take the uncorrected measured values C and M as the test results:

(1) In case the manufacturer can prove that there is no relation between the energy balance and fuel consumption,

(2) In case that ΔE_{batt} always corresponds to a battery charging,

(3) In case that ΔE_{batt} always corresponds to a battery decharging and ΔE_{batt} is within 1 per cent of the energy content of the consumed fuel (consumed fuel meaning the total fuel consumption over 1 cycle).

The change in battery energy content ΔE_{batt} can be calculated from the measured electricity balance Q as follows:

$$\Delta E_{batt} = \Delta SOC(\%) \cdot E_{TEbatt} \cong 0.0036 \cdot |\Delta Ah| \cdot V_{batt} = 0.0036 \cdot Q \cdot V_{batt} \quad (MJ)$$

with E_{TEbatt} (MJ) the total energy storage capacity of the battery and V_{batt} (V) the nominal battery voltage.

5.3.3. Fuel consumption correction coefficient (K_{fuel}) defined by the manufacturer

5.3.3.1. The fuel consumption correction coefficient (K_{fuel}) shall be determined from a set of n measurements performed by the manufacturer. This set should contain at least one measurement with $Q_i < 0$ and at least one with $Q_j > 0$.

If the latter condition cannot be realised on the driving cycle (Part One or Part Two) used in this test, then it is up to the Technical Service to judge the statistical significance of the extrapolation necessary to determine the fuel consumption value at $\Delta E_{batt} = 0$.

5.3.3.2. The fuel consumption correction coefficient (K_{fuel}) is defined as:

$$K_{fuel} = (n \cdot \Sigma Q_i C_i - \Sigma Q_i \cdot \Sigma C_i) / (n \cdot \Sigma Q_i^2 - (\Sigma Q_i)^2) \quad (l/100\ km/Ah)$$

where:

C_i = fuel consumption measured during i-th manufacturer's test (l/100 km)

Q_i = electricity balance measured during i-th manufacturer's test (Ah)

N = number of data

The fuel consumption correction coefficient shall be rounded to four significant figures (e.g. 0.xxxx or xx.xx). The statistical significance of the fuel consumption correction coefficient is to be judged by the Technical Service.

5.3.3.3. Separate fuel consumption correction coefficients shall be determined for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

5.3.4. Fuel consumption at zero battery energy balance (C_0)

5.3.4.1. The fuel consumption C_0 at $\Delta E_{batt} = 0$ is determined by the following equation:

$$C_0 = C - K_{fuel} \cdot Q \quad (l/100\ km)$$

Where:

C = fuel consumption measured during test (l/100 km)

Q = electricity balance measured during test (Ah)

5.3.4.2. Fuel consumption at zero battery energy balance shall be determined separately for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

5.3.5. CO_2-emission correction coefficient (K_{CO2}) defined by the manufacturer

5.3.5.1. The CO_2-emission correction coefficient (K_{CO2}) shall be determined as follows from a set of n measurements performed by the manufacturer. This set should contain at least one measurement with $Q_I < 0$ and at least one with $Q_j > 0$.

If the latter condition cannot be realised on the driving cycle (Part One or Part Two) used in this test, then it is up to the Technical Service to judge the statistical significance of the extrapolation necessary to determine the CO_2-emission value at $\Delta E_{batt} = 0$.

5.3.5.2. The CO_2-emission correction coefficient (K_{CO2}) is defined as:

$K_{CO2} = (n \cdot \Sigma Q_i M_i - \Sigma Q_i \cdot \Sigma M_i) / (n \cdot \Sigma Q_i^2 - (\Sigma Q_i)^2)$ (g/km/Ah)

Where:

M_i = CO_2-emission measured during i-th manufacturer's test (g/km)

Q_i = electricity balance during i-th manufacturer's test (Ah)

N = number of data

The CO_2-emission correction coefficient shall be rounded to four significant figures (e.g. 0.xxxx or xx.xx). The statistical significance of the CO_2-emission correction coefficient is to be judged by the Technical Service.

5.3.5.3. Separate CO_2-emission correction coefficients shall be determined for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

5.3.6. CO_2-emission at zero battery energy balance (M_0)

5.3.6.1. The CO_2-emission M_0 at $\Delta E_{batt} = 0$ is determined by the following equation:

$M_0 = M - K_{CO2} \cdot Q$ (g/km)

Where:

C = fuel consumption measured during test (l/100 km)

Q = electricity balance measured during test (Ah)

5.3.6.2. CO_2-emission at zero battery energy balance shall be determined separately for the CO_2-emission values measured over the Part One cycle and the Part Two cycle respectively.

6. Not Externally Chargeable (NOVC HEV) with an operating mode switch

6.1. These vehicles shall be tested in hybrid mode according to Annex 6 to this Regulation, using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex. If several hybrid modes are available, the test shall be carried out in the mode that is automatically set after turn on of the ignition key (normal mode).

6.1.1. Emissions of carbon dioxide (CO_2) and fuel consumption shall be determined separately for the Part One (urban driving) and the Part Two (extra-urban driving) of the specified driving cycle.

6.2. For preconditioning, at least 2 consecutive complete driving cycles (one Part One and one Part Two) are carried out without intermediate soak, using the applicable driving cycle and gear shifting prescriptions as defined in paragraph 1.4. of this annex.

6.3. Test results

6.3.1. The test results (fuel consumption C (l/100 km) and CO_2-emission M [g/km]) of this test are corrected in function of the energy balance ΔE_{batt} of the vehicle's battery.

The corrected values (C_0 [l/100 km] and M_0 (g/km)) should correspond to a zero energy balance ($\Delta E_{batt} = 0$), and are calculated using a correction coefficient determined by the manufacturer as defined below.

In case of other storage systems than an electric battery, ΔE_{batt} is representing $\Delta E_{storage}$, the energy balance of the electric energy storage device.

6.3.1.1. The electricity balance Q (Ah), measured using the procedure specified in Appendix 2 to this annex, is used as a measure of the difference in the vehicle battery's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance is to be determined separately for the Part One cycle and the Part Two cycle.

6.3.2. Under the conditions below, it is allowed to take the uncorrected measured values C and M as the test results:

(1) In case the manufacturer can prove that there is no relation between the energy balance and fuel consumption,

(2) In case that ΔE_{batt} always corresponds to a battery charging

(3) In case that ΔE_{batt} always corresponds to a battery discharging and ΔE_{batt} is within 1 per cent of the energy content of the consumed fuel (consumed fuel meaning the total fuel consumption over 1 cycle)

The change in battery energy content ΔE_{batt} can be calculated from the measured electricity balance Q as follows:

$$\Delta E_{batt} = \Delta SOC(\%) \cdot E_{TEbatt} \cong 0.0036 \cdot |\Delta Ah| \cdot V_{batt} = 0.0036 \cdot Q \cdot V_{batt} \quad (MJ)$$

With E_{TEbatt} (MJ) the total energy storage capacity of the battery and V_{batt} (V) the nominal battery voltage.

6.3.3. Fuel consumption correction coefficient (K_{fuel}) defined by the manufacturer

6.3.3.1. The fuel consumption correction coefficient (K_{fuel}) shall be determined from a set of n measurements performed by the manufacturer. This set should contain at least one measurement with $Q_i < 0$ and at least one with $Q_j > 0$.

If the latter condition cannot be realised on the driving cycle (Part One or Part Two) used in this test, then it is up to the Technical Service to judge the statistical significance of the extrapolation necessary to determine the fuel consumption value at $\Delta E_{batt} = 0$.

6.3.3.2. The fuel consumption correction coefficient (K_{fuel}) is defined as:

$$K_{fuel} = (n \cdot \Sigma Q_i C_i - \Sigma Q_i \cdot \Sigma C_i) / (n \cdot \Sigma Q_i^2 - (\Sigma Q_i)^2) \quad (l/100\ km/Ah)$$

where:

C_i = fuel consumption measured during i-th manufacturer's test (l/100 km)

Q_i = electricity balance measured during i-th manufacturer's test (Ah)

N = number of data

The fuel consumption correction coefficient shall be rounded to four significant figures (e.g. 0.xxxx or xx.xx). The statistical significance of the fuel consumption correction coefficient is to be judged by the Technical Service.

6.3.3.3. Separate fuel consumption correction coefficients shall be determined for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

6.3.4. Fuel consumption at zero battery energy balance (C_0)

6.3.4.1. The fuel consumption C_0 at $\Delta E_{batt} = 0$ is determined by the following equation:

$C_0 = C - K_{fuel} \cdot Q$ (l/100 km)

Where:

C = fuel consumption measured during test (l/100 km)

Q = electricity balance measured during test (Ah)

6.3.4.2. Fuel consumption at zero battery energy balance shall be determined separately for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

6.3.5. CO_2-emission correction coefficient (K_{CO2}) defined by the manufacturer

6.3.5.1. The CO_2-emission correction coefficient (K_{CO2}) shall be determined as follows from a set of n measurements performed by the manufacturer. This set should contain at least one measurement with $Q_i < 0$ and at least one with $Q_j > 0$.

If the latter condition cannot be realised on the driving cycle (Part One or Part Two) used in this test, then it is up to the Technical Service to judge the statistical significance of the extrapolation necessary to determine the CO_2-emission value at $\Delta E_{batt} = 0$.

6.3.5.2. The CO_2-emission correction coefficient (K_{CO2}) is defined as:

$K_{CO2} = (n \cdot \Sigma Q_i M_i - \Sigma Q_i \cdot \Sigma M_i) / (n \cdot \Sigma Q_i^2 - (\Sigma Q_i)^2)$ (g/km/Ah)

Where:

M_i = CO_2-emission measured during i-th manufacturer's test (g/km)

Q_i = electricity balance during i-th manufacturer's test (Ah)

n = number of data

The CO_2-emission correction coefficient shall be rounded to four significant figures (e.g. 0.xxxx or xx.xx). The statistical significance of the CO_2-emission correction coefficient is to be judged by the Technical Service.

6.3.5.3. Separate CO_2-emission correction coefficients shall be determined for the fuel consumption values measured over the Part One cycle and the Part Two cycle respectively.

6.3.6. CO_2-emission at zero battery energy balance (M_0)

6.3.6.1. The CO_2-emission M_0 at $\Delta E_{batt} = 0$ is determined by the following equation:

$M_0 = M - K_{CO2} \cdot Q$ (g/km)

Where:

C = fuel consumption measured during test (l/100 km)

Q = electricity balance measured during test (Ah)

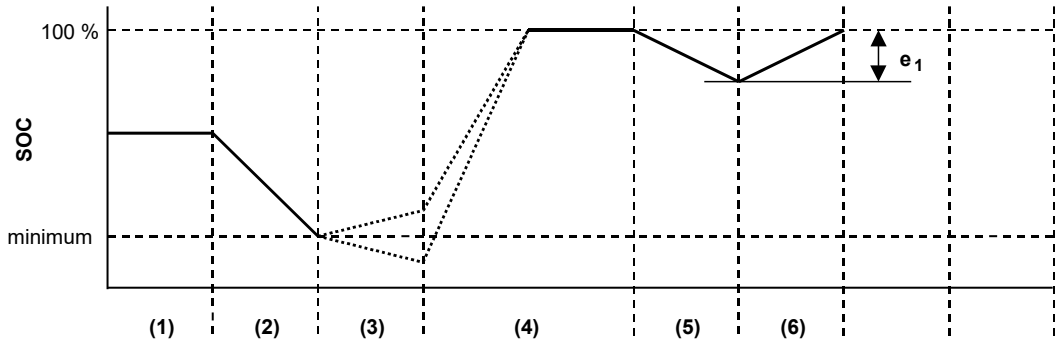
6.3.6.2. CO_2-emission at zero battery energy balance shall be determined separately for the CO_2-emission values measured over the Part One cycle and the Part Two cycle respectively.

Annex 8 - Appendix 1

Electrical energy/power storage device state of charge (SOC) profile for OVC HEVS

The SOC profiles for OVC-HEVs tested under conditions A and B are:

Condition A:



(1) Initial state of charge of the electrical energy/power storage device

(2) Discharge according to paragraph 3.2.1. or 4.2.2. of this annex

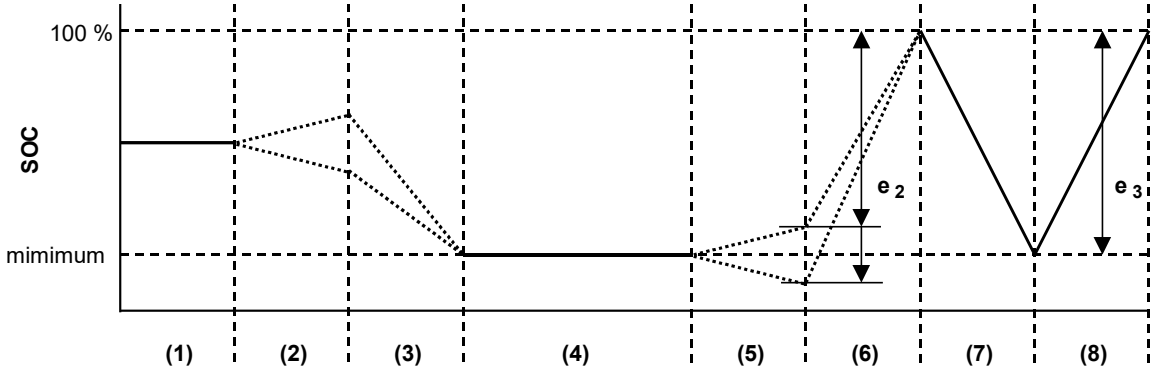
(3) Vehicle conditioning according to paragraphs 3.2.2.1./3.2.2.2. or 4.2.3.1./4.2.3.2. of this annex

(4) Charge during soak according to paragraphs 3.2.2.3. and 3.2.2.4. or 4.2.3.3. and 4.2.3.4. of this annex

(5) Test according to paragraph 3.2.3. or 4.2.4. of this annex

(6) Charging according to paragraph 3.2.4. or 4.2.5. of this annex

Condition B:



(1) Initial state of charge

(2) Vehicle conditioning according to paragraph 3.3.1.1. or 4.3.1.1. (optional) of this annex

(3) Discharge according to paragraph 3.3.1.1. or 4.3.1.1. of this annex

(4) Soak according to paragraph 3.3.1.2. or 4.3.1.2. of this annex

(5) Test according to paragraph 3.3.2. or 4.3.2. of this annex

(6) Charging according to paragraph 3.3.3. or 4.3.3. of this annex

(7) Discharging according to paragraph 3.3.4. or 4.3.4. of this annex

(8) Charging according to paragraph 3.3.5. or 4.3.5. of this annex

Annex 8 - Appendix 2

Method for measuring the electricity balance of the battery of OVC and NOVC HEVS

1. Introduction

1.1. The purpose of this appendix is to define the method and required instrumentation for measuring the electricity balance of Off-Vehicle Charging Hybrid Electric Vehicles (OVC HEV) and Not Off-Vehicle Charging Hybrid Electric Vehicles (NOVC HEVs). Measurement of the electricity balance is necessary

(a) To determine when the minimum state of charge of the battery has been reached during the test procedure defined in paragraphs 3. and 4. of this annex; and

(b) To correct the measured fuel consumption and CO_2-emissions for the change in battery energy content occurring during the test, using the method defined in paragraphs 5. and 6. of this annex.

1.2. The method described in this annex shall be used by the manufacturer for the measurements that are performed to determine the correction factors K_{fuel} and K_{CO_2}, as defined in paragraphs 5.3.3.2., 5.3.5.2., 6.3.3.2., and 6.3.5.2. of this annex.

The Technical Service shall check whether these measurements have been performed in accordance with the procedure described in this annex.

1.3. The method described in this annex shall be used by the Technical Service for the measurement of the electricity balance Q, as defined in paragraphs 3.2.3.2.2., 4.2.4.2.2., 5.3.4.1., 5.3.6.1., 6.3.4.1., and 6.3.6.1. of this annex.

2. Measurement equipment and instrumentation

2.1. During the tests as described in paragraphs 3., 4., 5. and 6. of this annex, the battery current shall be measured using a current transducer of the clamp-on type or the closed type. The current transducer (i.e. the current sensor without data acquisition equipment) shall have a minimum accuracy of 0.5 per cent of the measured value (in A) or 0.1 per cent of the maximum value of the scale.

OEM diagnostic testers are not to be used for the purpose of this test.

2.1.1. The current transducer shall be fitted on one of the wires directly connected to the battery. In order to easily measure battery current using external measuring equipment, manufacturers should preferably integrate appropriate, safe and accessible connection points in the vehicle. If that is not feasible, the manufacturer is obliged to support the Technical Service by providing the means to connect a current transducer to the wires connected to the battery in the above described manner.

2.1.2. The output of the current transducer shall be sampled with a minimum sample frequency of 5 Hz. The measured current shall be integrated over time, yielding the measured value of Q, expressed in Ampere hours (Ah).

2.1.3. The temperature at the location of the sensor shall be measured and sampled with the same sample frequency as the current, so that this value can be used for possible compensation of the drift of current transducers and, if applicable, the voltage transducer used to convert the output of the current transducer.

2.2. A list of the instrumentation (manufacturer, model no., serial No.) used by the manufacturer for determining:

(a) When the minimum state of charge of the battery has been reached during the test procedure defined in paragraphs 3. and 4. of this annex; and

(b) The correction factors K_{fuel} and K_{CO_2} (as defined in paragraphs 5.3.3.2., 5.3.5.2., 6.3.3.2., and 6.3.5.2. of this annex)

and the last calibration dates of the instruments (where applicable) should be provided to the Technical Service.

3. Measurement procedure

3.1. Measurement of the battery current shall start at the same time as the test starts and shall end immediately after the vehicle has driven the complete driving cycle.

3.2. Separate values of Q shall be logged over the Part One and Part Two of the cycle.

Annex 9

Method of measuring the electric range of vehicles powered by a hybrid electric power train and the OVC range of vehicles powered by a hybrid electric powertrain

1. Measurement of the electric range

The test method described hereafter permits to measure the electric range and OVC range of vehicles powered by a hybrid electric power train with off-vehicle charging (OVC-HEV as defined in paragraph 2. of Annex 8 to this Regulation).

2. Parameters, units and accuracy of measurements

Parameters, units and accuracy of measurements shall be as follows:

Parameter	*Unit*	*Accuracy*	*Resolution*
Time	s	+/-0.1 s	0.1 s
Distance	m	+/-0.1 per cent	1 m
Temperature degrees	C	+/-1 degree C	1 degree C
Speed	km/h	+/-1 per cent	0.2 km/h
Mass	kg	+/-0.5 per cent	1 kg
Electricity balance	Ah	+/-0.5 per cent	0.3 per cent

3. Test conditions

3.1. Condition of the vehicle

3.1.1. The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are at the ambient temperature.

3.1.2. The viscosity of the oils for the mechanical moving parts shall conform to the specifications of the vehicle manufacturer.

3.1.3. The lighting and light-signalling and auxiliary devices shall be off, except those required for testing and usual daytime operation of the vehicle.

3.1.4. All energy storage systems available for other than traction purposes (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the manufacturer.

3.1.5. If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the vehicle manufacturer in order to keep the temperature of the battery in the normal operating range.

The manufacturer's agent shall be in a position to attest that the thermal management system of the battery is neither disabled nor reduced.

3.1.6. The vehicle must have undergone at least 300 km or one full charge distances, whichever is longer with those batteries that are installed in the test vehicle.

3.2. Climatic conditions

For testing performed outdoors, the ambient temperature shall be between 5 °C and 32 °C.

The indoors testing shall be performed at a temperature between 20 °C and 30 °C.

4. Operation modes

The test method includes the following steps:

(a) Initial charge of the battery;

(b) Application of the cycle and measurement of the electric range.

Between the steps, if the vehicle shall move, it is pushed to the following test area (without regenerative recharging).

4.1. Initial charge of the battery

Charging the battery consists of the following procedures:

Note: "Initial charge of the battery" applies to the first charge of the battery, at the reception of the vehicle. In case of several combined tests or measurements, carried out consecutively, the first charge carried out shall be an "initial charge of the battery" and the following may be done in accordance with the "normal overnight charge" procedure.

4.1.1. Discharge of the battery

4.1.1.1. (Reserved)

4.1.1.2. For externally chargeable Hybrid Electric Vehicle (OVC HEV) without an operating mode switch as defined in Annex 8 to this Regulation:

4.1.1.2.1. The manufacturer shall provide the means for performing the measurement with the vehicle running in pure electric operating state.

4.1.1.2.2. The procedure shall start with the discharge of the electrical energy/power storage device of the vehicle while driving (on the test track, on a chassis dynamometer, etc.):

(a) At a steady speed of 50 km/h until the fuel consuming engine of the HEV starts up;

(b) Or, if a vehicle cannot reach a steady speed of 50 km/h without starting up the fuel consuming engine, the speed shall be reduced until the vehicle can run at a lower steady speed where the fuel consuming engine just does not start up for a defined time/distance (to be specified between technical service and manufacturer);

(c) Or with manufacturers' recommendation.

The fuel consuming engine shall be stopped within ten seconds of it being automatically started.

4.1.1.3. For externally chargeable Hybrid Electric Vehicle (OVC HEV) with an operating mode switch as defined in Annex 8 to this Regulation:

4.1.1.3.1. If there is not a pure electric position, the manufacturer shall provide the means for performing the discharge of the battery with the vehicle running in pure electric operating state.

4.1.1.3.2. The procedure shall start with the discharge of the electrical energy/power storage device of the vehicle while driving with the switch in pure electric position (on the test track, on a chassis dynamometer, etc.) at a steady speed of 70 per cent +/-5 per cent of the maximum thirty minutes speed of the vehicle.

4.1.1.3.3. Stopping the discharge occurs:

(a) When the vehicle is not able to run at 65 per cent of the maximum thirty minutes speed; or

(b) When an indication to stop the vehicle is given to the driver by the standard onboard instrumentation; or

(c) After covering the distance of 100 km.

4.1.1.3.4. If the vehicle is not equipped with a pure electric operating state, the electrical energy/power storage device discharge shall be achieved by driving the vehicle (on the test track, on a chassis dynamometer, etc.):

(a) At a steady speed of 50 km/h until the fuel consuming engine of the HEV starts up; or

(b) If a vehicle cannot reach a steady speed of 50 km/h without starting up the fuel consuming engine, the speed shall be reduced until the vehicle can run a lower steady speed where the fuel consuming engine just does not start up for a defined time/distance (to be specified between Technical Service and manufacturer); or

(c) With manufacturers' recommendation.

The fuel consuming engine shall be stopped within ten seconds of it being automatically started.

4.1.2. Application of a normal overnight charge

For a pure electric vehicle, the battery shall be charged according to the normal overnight charge procedure, as defined in paragraph 2.4.1.2. of Annex 7 to this Regulation, for a period not exceeding twelve hours.

For an OVC HEV, the battery shall be charged according to the normal overnight charge procedure as described in paragraph 3.2.2.5. of Annex 8 to this Regulation.

4.2. Application of the cycle and measurement of the range

4.2.1. (Reserved)

4.2.2. For hybrid electric vehicles

4.2.2.1. To determine the electric range of a hybrid electric vehicle

4.2.2.1.1. The applicable test sequence and accompanying gear shift prescription, as defined in paragraph 1.4. of Annex 8, is applied on a chassis dynamometer adjusted as described in Appendices 1, 6 and 7 of Annex 4a to Regulation No. 83, until the end of the test criteria is reached.

To determine the electric range (De) of OVC HEVs equipped with an operating mode switch the same operating mode position, in accordance with Table 4.1.3 and paragraph 4.2.1 of Annex 8 to this Regulation, shall be used as for the determination of CO_2 and fuel consumption.

4.2.2.1.2. To measure the electric range the end of the test criteria is reached when the vehicle is not able to meet the target curve up to 50 km/h, or when an indication from the standard on-board instrumentation is given to the driver to stop the vehicle or when the battery has reached its minimum state of charge. Then the vehicle shall be slowed down to 5 km/h by releasing the accelerator pedal, without touching the brake pedal and then stopped by braking.

4.2.2.1.3. At a speed over 50 km/h, when the vehicle does not reach the required acceleration or speed of the test cycle, the accelerator pedal shall remain fully depressed until the reference curve has been reached again. The maximum possible speed in pure electric operating state in the first combined cycle shall be recorded in the test report and in the drivers' handbook of production vehicles.

During this procedure, the electricity balance (QES_i) of the high voltage battery (expressed in Ampere hours), measured continuously and using the procedure specified in Appendix 2 to the Annex 8 to this Regulation, the vehicle speed (VES_i) and De_i shall be recorded at the instant when the fuel consuming engine starts and the accumulation of De_i shall be stopped. Further accumulation of De_i shall not be permitted unless:

(a) The fuel consuming engine stopped running; and

(b) VES_i has returned to the same or any lower level of VES_i as recorded before the fuel consuming engine started; and

(c) QES_i has returned to the same or any lower level of QES_i as recorded before the last fuel consuming engine start or, where applicable, to the same or any lower level of QSA_i as determined in accordance with paragraph 4.2.2.1.3.1. of this annex.

This procedure shall be followed until the end of the test as defined in paragraph 4.2.2.1.2. of this annex.

4.2.2.1.3.1. During the first deceleration phase following each start of the fuel consuming engine, when the vehicle speed is less than the vehicle speed at which the fuel consuming engine started previously:

(a) The distance covered with engine off should be counted as De_i; and

(b) The increase in electricity balance during this period should be recorded (ΔQrb_i); and

(c) The electricity balance when the fuel consuming engine starts (QES_i) defined previously should be corrected by ΔQrb_i (hence new $QSA_i = QES_i + \Delta Qrb_i$);

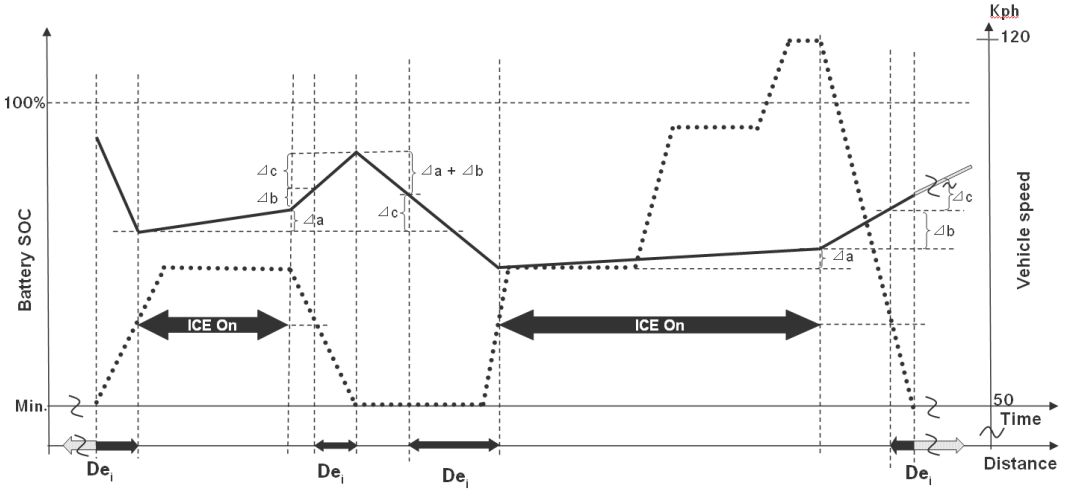
VES_i = Vehicle speed at the moment when the ICE starts;

QES_i = Energy of the battery at the moment when the ICE starts;

ΔQrb_i = The increase in electricity balance during deceleration phases, when the vehicle speed is less than the vehicle speed at which the ICE started previously;

QSA_i = Energy of the battery at the moment of the further accumulation of De.

Example:



⊿a = Charged by ICE

⊿b = Charged by regeneration (vehicle acceleration by ICE)

⊿c = Charged by regeneration (ΔQrb_i, vehicle acceleration with energy from battery)

$De = \Sigma De_i$

De_i = Distances where the propulsive energy was not produced by ICE

_____ Battery SOC

_____ Vehicle Speed

4.2.2.1.4. To respect human needs, up to three interruptions are permitted between test sequences, of no more than 15 minutes in total.

4.2.2.1.5. At the end, the electric range is the sum of all cycle portions De_i in km. It shall be rounded to the nearest whole number.

4.2.2.2. To determine the OVC range of a hybrid electric vehicle

4.2.2.2.1. The applicable test sequence and accompanying gear shift prescription, as defined in paragraph 1.4. of Annex 8, is applied on a chassis dynamometer adjusted as described in Appendices 2, 3 and 4 to Annex 4 to Regulation No. 83, until the end of the test criteria is reached.

4.2.2.2.2. To measure the OVC range the end of the test criteria is reached when the battery has reached its minimum state of charge according to the criteria defined in Annex 8 to this Regulation, paragraph 3.2.3.2.2. or 4.2.4.2.2. Driving is continued until the final idling period in the extra-urban cycle.

4.2.2.2.3. To respect human needs, up to three interruptions are permitted between test sequences, of no more than fifteen minutes in total.

4.2.2.2.4. At the end, the total distance driven in km, rounded to the nearest whole number, is the OVC range of the hybrid electric vehicle.

DRAFT FOR CONSULTATION

Annex 10

Emissions test procedure for a vehicle equipped with a periodically regenerating system

1. Introduction

1.1. This annex defines the specific provisions regarding type approval of a vehicle equipped with a periodically regenerating system as defined in paragraph 2.16. of this Regulation.

1.2. Alternative procedure

As an alternative to the procedure set out in this Annex, the manufacturer may use the results determined by the WLTP procedure, described in Appendix 1 to Annex 6 of the UN GTR No. 15, Amendment 4.

In this case, the following additional provisions apply:

(a) At the request of the manufacturer and with the agreement of the responsible authority, the Extra High phase may be excluded for determining the regenerative factor Ki for Class 2 and Class 3 vehicles.

(b) Instead of the criterion described in paragraph 2.2. of this Annex the criterion shall be based on the WLTP test mass: The test mass of each vehicle in the family must be less than or equal to the test mass of the vehicle used for the Ki demonstration test plus 250 kg.

(c) Additive or multiplicative Ki is valid and is to be applied accordingly."

2. Scope and extension of the type approval

2.1. Vehicle family groups equipped with periodically regenerating system

The procedure applies to vehicles equipped with a periodically regenerating system as defined in paragraph 2.16. of this Regulation. For the purpose of this annex vehicle family groups may be established. Accordingly, those vehicle types with regenerative systems, whose parameters described below are identical, or within the stated tolerances, shall be considered to belong to the same family with respect to measurements specific to the defined periodically regenerating systems.

2.1.1. Identical parameters are:

Engine:

(a) Number of cylinders;

(b) Engine capacity (±15 per cent);

(c) Number of valves;

(d) Fuel system;

(e) Combustion process (2 stroke, 4 stroke, rotary).

Periodically regenerating system (i.e. catalyst, particulate trap):

(a) Construction (i.e. type of enclosure, type of precious metal, type of substrate, cell density);

(b) Type and working principle;

(c) Dosage and additive system;

(d) Volume (±10 per cent);

(e) Location (temperature ±50 °C at 120 km/h or 5 per cent difference of maximum temperature / pressure).

2.2. Vehicle types of different reference masses

The K_i factor developed by the procedures in this annex for type approval of a vehicle type with a periodically regenerating system as defined in paragraph 2.16. of this Regulation, may be extended to other vehicles in the family group with a reference mass within the next two higher equivalent inertia classes or any lower equivalent inertia.

2.3. Instead of carrying out the test procedures defined in the following paragraph, a fixed K_i value of 1.05 may be used, if the Technical Service sees no reason that this value could be exceeded.

3. Test procedure

The vehicle may be equipped with a switch capable of preventing or permitting the regeneration process provided that this operation has no effect on original engine calibration. This switch shall be permitted only for the purpose of preventing regeneration during loading of the regeneration system and during the pre-conditioning cycles. However, it shall not be used during the measurement of emissions during the regeneration phase; rather the emission test shall be carried out with the unchanged Original Equipment Manufacturers (OEM) control unit.

3.1. Measurement of carbon dioxide emission and fuel consumption between two cycles where regenerative phases occur

3.1.1. The average of carbon dioxide emission and fuel consumption between regeneration phases and during loading of the regenerative device shall be determined from the arithmetic mean of several approximately equidistant (if more than 2) Type I operating cycles or equivalent engine test bench cycles. As an alternative, the manufacturer may provide data to show that the carbon dioxide emission and fuel consumption remain constant (±4 per cent) between regeneration phases. In this case, the carbon dioxide emission and fuel consumption measured during the regular Type I test may be used. In any other case emissions measurement for at least two Type I operating cycles or equivalent engine test bench cycles must be completed: one immediately after regeneration (before new loading) and one as close as possible prior to a regeneration phase. All emissions measurements and calculations shall be carried out according to Annex 6 to this Regulation. Determination of average emissions for a single regenerative system shall be according to paragraph 3.3. of this annex and for multiple regeneration systems according to paragraph 3.4. of this annex.

3.1.2. The loading process and K_i determination shall be made during the Type I operating cycle, on a chassis dynamometer or on an engine test bench using an equivalent test cycle. These cycles may be run continuously (i.e. without the need to switch the engine off between cycles). After any number of completed cycles, the vehicle may be removed from the chassis dynamometer, and the test continued at a later time.

3.1.3. The number of cycles (D) between two cycles where regeneration phases occur, the number of cycles over which emissions measurements are made (n), and each emissions measurement (M'_{sij}) shall be reported in Annex 1 to this Regulation, items 4.1.11.2.1.10.1. to 4.1.11.2.1.10.4. or 4.1.11.2.5.4.1. to 4.1.11.2.5.4.4. as applicable.

3.2. Measurement of carbon dioxide emission and fuel consumption during regeneration

3.2.1. Preparation of the vehicle, if required, for the emissions test during a regeneration phase, may be completed using the preparation cycles in paragraph 6.3. of Annex 4A to Regulation No. 83 or equivalent engine test bench cycles, depending on the loading procedure chosen in paragraph 3.1.2. above.

3.2.2. The test and vehicle conditions for the test described in Annex 6 to this Regulation apply before the first valid emission test is carried out.

3.2.3. Regeneration must not occur during the preparation of the vehicle. This may be ensured by one of the following methods:

3.2.3.1. A "dummy" regenerating system or partial system may be fitted for the pre-conditioning cycles.

3.2.3.2. Any other method agreed between the manufacturer and the type approval authority.

3.2.4. A cold-start exhaust emission test including a regeneration process shall be performed according to the Type I operating cycle, or equivalent engine test bench cycle. If the emissions tests between two cycles where regeneration phases occur are carried out on an engine test bench, the emissions test including a regeneration phase shall also be carried out on an engine test bench.

3.2.5. If the regeneration process requires more than one operating cycle, subsequent test cycle(s) shall be driven immediately, without switching the engine off, until complete regeneration has been achieved (each cycle shall be completed). The time necessary to set up a new test should be as short as possible (e.g. particular matter filter change). The engine must be switched off during this period.

3.2.6. The carbon dioxide emission and fuel consumption values during regeneration (M_{ri}) shall be calculated according to Annex 6 to this Regulation. The number of operating cycles (d) measured for complete regeneration shall be recorded.

3.3. Calculation of the combined carbon dioxide emission and fuel consumption of a single regenerative system

(1) $$M_{si} = \frac{\sum_{j=1}^{n} M'_{sij}}{n} \qquad n \geq 2$$

(2) $$M_{ri} = \frac{\sum_{j=1}^{d} M'_{rij}}{d}$$

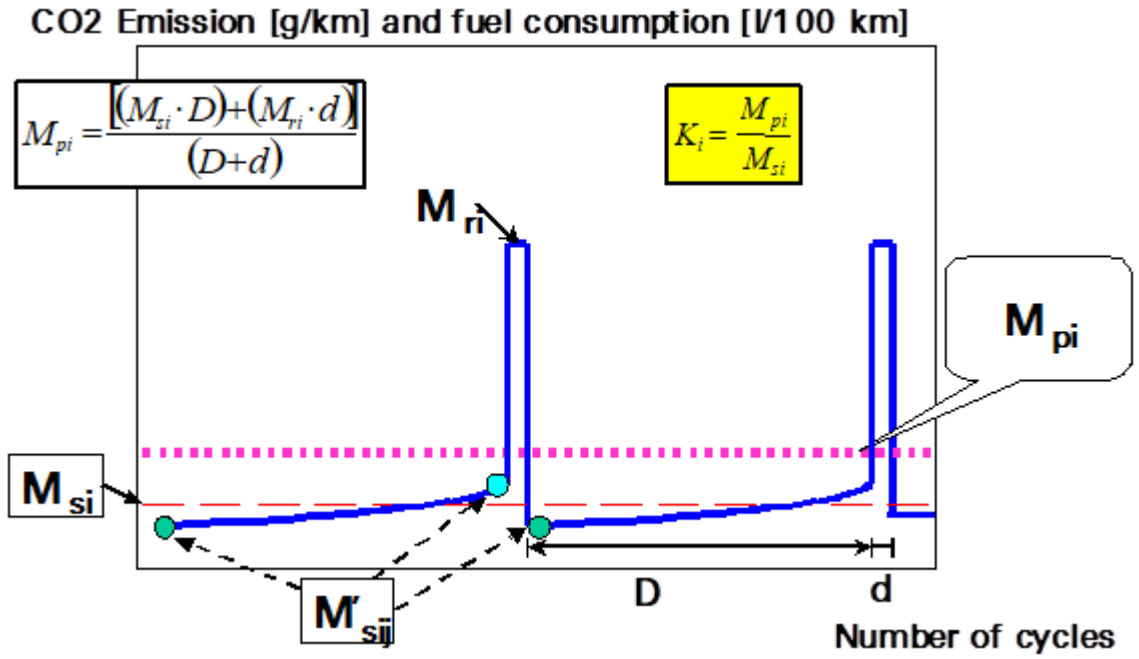
(3) $$M_{pi} = \left\{\frac{M_{si} \cdot D + M_{ri} \cdot d}{D + d}\right\}$$

Where for each carbon dioxide emission and fuel consumption considered:

M'_{sij}	=	mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle (or equivalent engine test bench cycle) without regeneration;
M'_{rij}	=	mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle (or equivalent engine test bench cycle) during regeneration. (when n > 1, the first Type I test is run cold, and subsequent cycles are hot);
M_{si}	=	mean mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle without regeneration;
M_{ri}	=	mean mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle during regeneration;
M_{pi}	=	mean mass emission of CO_2 in g/km and fuel consumption in l/100 km;
n	=	number of test points at which emissions measurements (Type I operating cycles or equivalent engine test bench cycles) are made between two cycles where regenerative phases occur, ≥ 2;
d	=	number of operating cycles required for regeneration;
D	=	number of operating cycles between two cycles where regenerative phases occur.

For an illustration of measurement parameters see Figure 10/1.

Figure 10/1
Parameters measured during carbon dioxide emission and fuel consumption test during and between cycles where regeneration occurs (schematic example, the emissions during "D" may increase or decrease)



3.3.1. Calculation of the regeneration factor K for carbon dioxide emission and fuel consumption (i) considered

$$K_i = M_{pi} / M_{si}$$

M_{si}, M_{pi} and K_i results shall be recorded in the test report delivered by the Technical Service.

K_i may be determined following the completion of a single sequence.

3.4. Calculation of combined CO_2-emission and fuel consumption of multiple periodic regenerating systems

(1) $$M_{sik} = \frac{\sum_{k=1}^{n_k} M'_{sik,j}}{n_k} \quad n_k \geq 2$$

(2) $$M_{rik} = \frac{\sum_{k=1}^{d_k} M'_{rik,j}}{d_k}$$

(3) $$M_{si} = \frac{\sum_{k=1}^{x} M_{sik} \cdot D_k}{\sum_{k=1}^{x} D_k}$$

(4) $$M_{ri} = \frac{\sum_{k=1}^{x} M_{rik} \cdot d_k}{\sum_{k=1}^{x} d_k}$$

(5) $$M_{pi} = \frac{M_{si} \cdot \sum_{k=1}^{x} D_k + M_{ri} \cdot \sum_{k=1}^{x} d_k}{\sum_{k=1}^{x} (D_k + d_k)}$$

(6) $$M_{pi} = \frac{\sum_{k=1}^{x} (M_{sik} \cdot D_k + M_{rik} \cdot d_k)}{\sum_{k=1}^{x} (D_k + d_k)}$$

(7) $$K_i = \frac{M_{pi}}{M_{si}}$$

Where:

M_{si} = mass emission of all events k of CO_2 in g/km and fuel consumption in l/100 km (i) without regeneration;

M_{ri} = mass emission of all events k of CO_2 in g/km and fuel consumption in l/100 km (i) during regeneration;

M_{pi} = mass emission of all events k of CO_2 in g/km and fuel consumption in l/100 km (i);

M_{sik} = mass emission of event k of CO_2 in g/km and fuel consumption in l/100 km (i) without regeneration;

M_{rik} = mass emission of event k of CO_2 in g/km and fuel consumption in l/100 km (i) during regeneration;

$M'_{sik,j}$ = mass emission of event k of CO_2 in g/km and fuel consumption in l/100 km (i) over one Type I operating cycle (or equivalent engine test bench cycle) without regeneration measured at point j; $1 \leq j \leq n$;

$M'_{rik,j}$ = mass emission of event k of CO_2 in g/km and fuel consumption in l/100 km (i) over one Type I operating cycle (or equivalent engine test bench cycle) during regeneration (when $j > 1$, the first Type I test is run cold, and subsequent cycles are hot) measured at operating cycle j; $1 \leq j \leq d$;

nk = number of test points of event k at which emissions measurements (Type I operating cycles or equivalent engine test

bench cycles) are made between two cycles where regenerative phases occur, ≥;

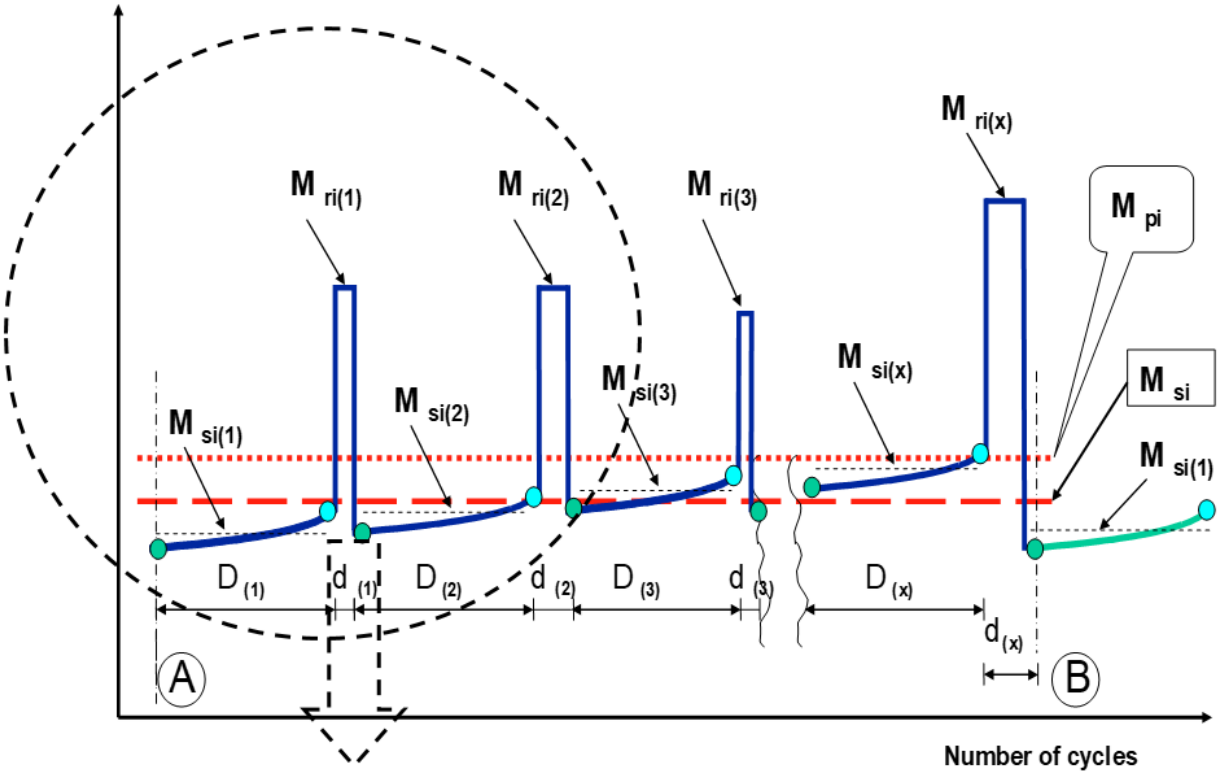
dk = number of operating cycles of event k required for regeneration;

Dk = number of operating cycles of event k between two cycles where regenerative phases occur.

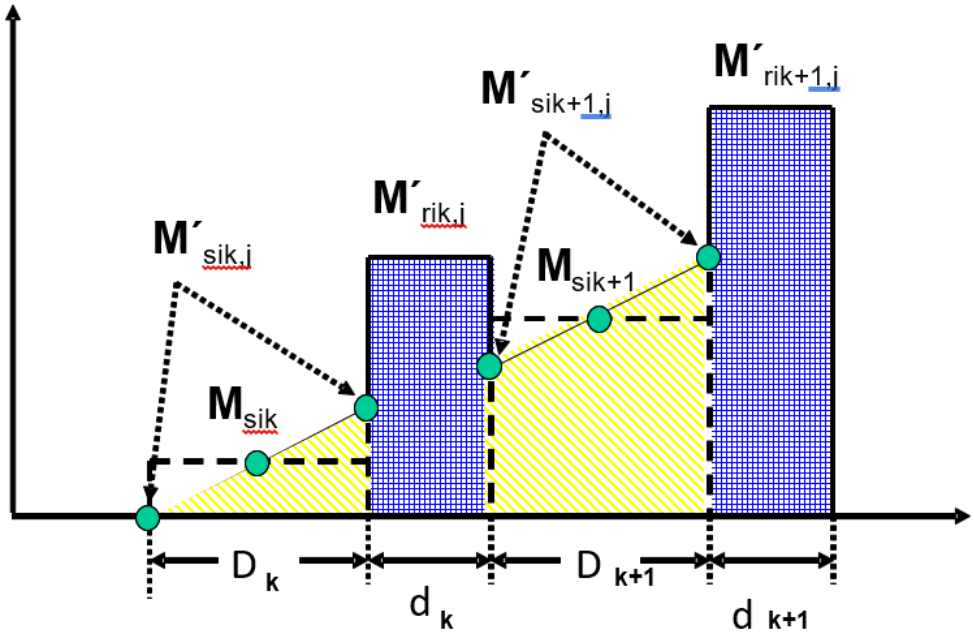
For an illustration of measurement parameters see Figure 10/2 (below)

Figures 10/2 and 10/3

Parameters measured during emissions test during and between cycles where regeneration occurs (schematic example)



For more details of the schematic process see Figure 10/3



For application of a simple and realistic case, the following description gives a detailed explanation of the schematic example shown in Figure 10/3 above):

(1) DPF: regenerative, equidistant events, similar emissions (±15 per cent) from event to event

$D_k = D_{k+1} = D_1$

$d_k = d_{k+1} = d_1$

$M_{rik} - M_{sik} = M_{rik+1} - M_{sik+1}$

$n_k = n$

(2) $DeNO_x$: the desulphurisation (SO_2 removal) event is initiated before an influence of sulphur on emissions is detectable (±15 per cent of measured emissions) and in this example for exothermic reason together with the last DPF regeneration event performed.

$M'_{sik,j=1}$ = constant → $M_{sik} = M_{sik+1} = M_{si2}$
$M_{rik} = M_{rik+1} = M_{ri2}$

For SO_2 removal event:

M_{ri2}, M_{si2}, d_2, D_2, $n_2 = 1$

(3) Complete system (DPF + $DeNO_x$):

$$M_{si} = \frac{n \cdot M_{si1} \cdot D_1 + M_{si2} \cdot D_2}{n \cdot D_1 + D_2}$$

$$M_{ri} = \frac{n \cdot M_{ri1} \cdot d_1 + M_{ri2} \cdot d_2}{n \cdot d_1 + d_2}$$

$$M_{pi} = \frac{M_{si} + M_{ri}}{n \cdot (D_1 + d_1) + D_2 + d_2} = \frac{n \cdot (M_{si1} \cdot D_1 + M_{ri1} \cdot d_1) + M_{si2} \cdot D_2 + M_{ri2} \cdot d_2}{n \cdot (D_1 + d_1) + D_2 + d_2}$$

The calculation of the factor (K_i) for multiple periodic regenerating systems is only possible after a certain number of regeneration phases for each system. After performing the complete procedure (A to B, see Figure 10/2), the original starting conditions A should be reached again.

3.4.1. Extension of approval for a multiple periodic regeneration system

3.4.1.1. If the technical parameter(s) and or the regeneration strategy of a multiple regeneration system for all events within this combined system are changed, the complete procedure including all regenerative devices should be performed by measurements to update the multiple K_i factor.

3.4.1.2. If a single device of the multiple regeneration system changed only in strategy parameters (i.e. such as "D" and/or "d" for DPF) and the manufacturer could present technical feasible data and information to the Technical Service that:

(a) There is no detectable interaction with the other device(s) of the system, and

(b) The important parameters (i.e. construction, working principle, volume, location etc.) are identical,

the necessary update procedure for K_i could be simplified.

As agreed between the manufacturer and the Technical Service in such a case only a single event of sampling/storage and regeneration should be performed and the test results ("M_{si}", "M_{ri}") in combination with the changed parameters ("D" and/or "d") could be introduced in the relevant formula(s) to update the multiple K_i factor in a mathematical way under substitution of the existing basis K_i factor formula(s).

APPENDIX B

Calculation of NEDC equivalent carbon dioxide values for vehicles tested to the WLTP or US EPA test cycle

1. Introduction

This appendix specifies an approved method for calculating an NEDC equivalent carbon dioxide emissions value for the purposes of this vehicle standard.

2. Definitions

4-phase WLTP	means a vehicle with a carbon dioxide emissions value determined over the complete cycle of the WLTP as adopted in Annex XXI of EU Regulation 2017/1151 or EU Regulation 2025/1706 or Level 1A or Level 2 of UN Regulation No.154.
3-phase WLTP	means a vehicle with a carbon dioxide emissions value determined over the complete cycle of the WLTP as adopted in Level 1B of UN Regulation No.154.
US 2-cycle test procedure	means a vehicle with a carbon dioxide emissions value determined over the 'Federal Test Procedure' and the 'Highway Fuel Economy Test' specified in Title 40 of the United States Code of Federal Regulations, Part 600 – Fuel Economy and Greenhouse Gas Exhaust Emissions of Motor Vehicles.

3. Calculation of an NEDC equivalent carbon dioxide emissions value for *Pure ICE* vehicles and *NOVC-HEVs*

3.1 *Pure ICE vehicles* and *NOVC-HEVs* with a carbon dioxide emissions value determined in accordance with the *'4-phase WLTP'*, '*3-phase WLTP'* or the '*US 2-cycle'* test procedure, may use the following equation to calculate the vehicle's NEDC equivalent carbon dioxide emissions value for the purposes of this vehicle standard:

$$CO_{2,NEDC} = a \times CO_{2,type-approval} + b$$

Where:

$CO_{2,NEDC}$	is the NEDC equivalent carbon dioxide emissions value in grams per kilometre (g/km)
$CO_{2,type-approval}$	is the carbon dioxide emissions value (in g/km) determined over the original test procedure

Parameters a and b are defined in Table B1 depending on the procedure used for determining the reported carbon dioxide emissions value determined over the original test procedure, vehicle category, and fuel type.

Table B1: Parameters a and b for the conversion of carbon dioxide emission values of Pure ICE vehicles and NOVC-HEVs.

Original test procedure	ADR vehicle category	Fuel type	a	b
Vehicles tested in accordance with the *4 phase WLTP*	MA, MB, MC	Petrol	0.9294	-13.2248
	NB1	Petrol	0.9294	-13.2248
	MA, MB, MC	Diesel	0.8075	1.8475
	NB1	Diesel	0.7633	1.0199
Vehicles tested in accordance with the *3 phase WLTP*	MA, MB, MC	Petrol	0.7946	11.8702
	NB1	Petrol	0.7946	11.8702
	MA, MB, MC	Diesel	0.7773	10.0080
	NB1	Diesel	0.7347	8.7332
Vehicles tested in accordance with the *US 2-cycle* test procedure	MA, MB, MC	Petrol	0.9849	0.9819
	NB1	Petrol	0.9849	0.9819
	MA, MB, MC	Diesel	1.0478	-3.0061
	NB1	Diesel	1.0419	-3.2551

4. Calculation of an NEDC equivalent carbon dioxide emissions value for *OVC-HEVs*

4.1 If the vehicle is an *OVC-HEV*, the following procedure may be used to determine the vehicle's NEDC equivalent carbon dioxide emissions value:

4.1.1 The declared charge sustaining CO_2 emissions value from the original test procedure may be converted to a NEDC equivalent charge sustaining CO_2 emissions value $CO_{2,CS,NEDC}$ using the following equation:

$$CO_{2,CS,NEDC} = a \times CO_{2CS,type-approval} + b$$

Where:

$CO_{2,CS,type-approval}$ is the carbon dioxide emissions value (in g/km) determined over the original test procedure

Parameters a and b are defined in Table B1 depending on the procedure used for determining the reported carbon dioxide emissions value determined over the original test procedure, vehicle category, and fuel type of the internal combustion engine.

4.1.2 The NEDC equivalent carbon dioxide emissions value ($CO_{2,NEDC}$) for the vehicle shall then be calculated using the following equation:

$$CO_{2,NEDC} = CO_{2,CS,NEDC} \cdot \frac{25km}{EAER + 25km}$$

Where:

$CO_{2,CS,NEDC}$ is the NEDC equivalent charge-sustaining CO_2 emissions value in g/km determined in accordance with clause 4.2.1

EAER is the equivalent all-electric range determined in accordance with the original test procedure in km

4.2 At the choice of the manufacturer, if the vehicle is an *OVC-HEV* tested in accordance with the *'4-phase WLTP'*, with a utility factor weighted carbon dioxide emissions value calculated using:

a. the d_n utility factor curve specified in Annex B8-Appendix 5 of the 00 or 01 series of UN Regulation No. 154, or EU Regulation 2017/1151; or

b. the d_{nea} utility factor curve specified in Annex B8-Appendix 5 of Level 1A or Level 2 of UN Regulation No. 154, or EU Regulation 2023/443;

the vehicle's NEDC equivalent carbon dioxide emissions value may be calculated using the following equation:

$$CO_{2,NEDC} = a \times CO_{2,type-approval} + b$$

Where:

$CO_{2,NEDC}$ is the NEDC equivalent carbon dioxide emissions value in g/km

$CO_{2,type-approval}$ is the carbon dioxide emissions value declared in accordance with the original test procedure

Parameters a and b are defined in Table A2 depending on the procedure used for determining the reported declared carbon dioxide emissions value, the vehicle category, and the fuel type of the internal combustion engine.

Table B2: Parameters a and b for the conversion of carbon dioxide emission values of off-vehicle charging hybrid electric vehicles (OVC-HEVs).

Original test procedure	ADR vehicle category	Fuel type	a	b
OVC-HEVs tested in accordance with the 4 phase WLTP, with a utility factor weighted CO_2 value calculated using: the d_n (Euro 6d) utility factor curve specified in Annex B8-Appendix 5 of the 00 or 01 series of UN Regulation No. 154 (Level 1A or Level 2), or EU Regulation 2017/1151 as amended by EU Regulation 2018/1832; or the d_{nea} (Euro 6e-EA) utility factor curve specified in Annex B8-Appendix 5 of UN Regulation No. 154 (Level 1A or Level 2), or EU Regulation 2017/1151 as amended by EU Regulation 2023/443.	MA, MB, MC	Petrol	0.6879	13.9135
	NB1	Petrol	0.6879	13.9135
	MA, MB, MC	Diesel	0.7084	14.5883
	NB1	Diesel	0.7084	14.5883

5. Supporting information requirements

5.1. For each vehicle type reporting a carbon dioxide or fuel consumption value determined in accordance with this Appendix, the following information must be recorded in the manufacturer's *Supporting Information*:

5.1.1. the vehicle's NEDC equivalent carbon dioxide emissions determined in accordance with clause 3.1, 4.1 or 4.2; and

5.1.2 the vehicle's carbon dioxide emissions value (in g/km) determined in accordance with the original test procedure; and

5.1.3 the vehicle's ADR vehicle category; and

5.1.4 the fuel-type for the vehicle's internal combustion engine ("petrol" or "diesel"); and

5.1.5 the vehicle's powertrain type ("Pure ICE vehicle", "NOVC-HEV" or "OVC-HEV").

5.2. If the vehicle is an *OVC-HEV* with an NEDC equivalent CO_2 value determined in accordance with clause 4.1 of this Appendix, the following information must also be recorded in the manufacturer's *Supporting Information*:

5.2.1 the vehicle's charge sustaining carbon dioxide emissions value in g/km, determined in accordance with the original test procedure; and

5.2.2 the vehicle's NEDC equivalent charge sustaining carbon dioxide emissions in g/km, calculated in accordance with clause 3.1; and

5.2.3 the vehicle's equivalent all electric range in km, determined in accordance with the original test procedure.