Submitted by the expert of Germany, Japan, Korea, Sweden, Switzerland, United Kingdom, European Commission and the International Organization of Motor Vehicle Manufacturer

Informal document **GRPE-92-09**
92nd GRPE, 26-28 March 2025
Agenda item 3.(a)

Proposal for a new series of amendments to UN Regulation No. 154 (Worldwide harmonized Light vehicles Test Procedures (WLTP))

Submitted by Germany, Japan, Korea, Sweden, Switzerland, United Kingdom, the European Commission and the International Organization of Motor Vehicle Manufacturers

This document provides proposals for new series of UN Regulation No. 154 on 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). The new series of amendments is required in order to align the Regulation with the latest regional requirements. The proposal also clarifies the provisions which may lead to multiple interpretations and corrects errors.

Separate Informal Document (GRPE-92-08) which focuses on new EU requirement is prepared by European Commission.

In addition, the structure change of this Regulation is under the discussion. Therefore, the consolidated version will be prepared after the decision during 92nd GRPE.

I. Proposal Summary

items	Main Paragraph/Annex	Brief explanation	* Purpose	Applicable to Level			Text proposals	Proposed by
				1A	1B	2		
On-Board Monitoring	Please take a look at GRPR-92-08e			✔		✔	Please take a look at GRPE-92-08e	European Commission
New PN provision				✔		✔		
New SHED Limit				✔		✔		
Updated durability provisions				✔		✔		
Anti-tampering and (cyber) security				✔		✔		
Requirement for manipulation devices / strategies				✔		✔		
Environmental Vehicle Passport				✔		✔		
EV range at low temperature				✔		✔		
OBFCM				✔		✔		
OBFCM	5. / 6. / 8. Appendix 2 / 5	apply to Level 1B including all powertrain	NR		✔	✔	4 ~ 16	Japan
OVC-HEV family definition	6.3.2.2. Annex B8 4.1.2. Table A8/8	delete the “different # of CD cycle” from interpolation family criteria for Level 1B due to no impact on the relevant test results. delete unnecessary test result under the Level 1B condition	TC		✔	✔	17 ~ 18	Japan
Interpolation family definition	6.3.2.4.	Consistent terminology between Level 1 and 2	EC	✔	✔		19	Switzer-land

* Purpose NR : New Requirement, H : Harmonisation
TC : Technical Correction, IPT : Improve Test Procedure EC : Editorial Correction

items	Main Paragraph/Annex	Brief explanation	* Purpose	Applicable to Level			Text proposals	Proposed by
				1A	1B	2		
OBD text	6.8.2. Table 4A, 4B	correct wrong requirement and make clear description	EC	✔	✔	✔	20	Korea
[Inducement system	Appendix 6	avoid mis-interpretation (can be withdrawn)	TC	tbd	tbd	tbd	21	Japan]
HEVs test cycle classification	3.7.1. / 6.3.2.3. Annex B1 2.3.2. Annex B4 Table A4/3 A4/7 Annex B8 1.4. / 3.4.	apply cycle classification for PEV in addition to pure ICE vehicles the system power defined by newly developed UNR177 is used to determine the power to mass ratio	NR	tbc	✔	✔	22 ~ 26	Japan
Run-in procedure (already incorporated into GRPE/2025/4 and 5)	Annex B4 4.2.1.8.1.	allow less distance run-in for EVs to reduce the testing burden as an option	ITP	✔	✔	✔	27	OICA
Trace tolerance	Annex B6 2.6.8.3.1.2.	avoid mis-interpretation	TC	✔	✔	✔	28	Germany
[Cycle energy demand for PEV	2. / 3. Annex B7, B8 Appendix 9	consider the recuperated energy for PEVs when determining the cycle energy demand	TC	tbd	tbd	tbd	29 ~ 32	OICA]
Mechanical robot driving	Annex B8 3.4.1.	allow usage of robot driver to reduce test driver physical load as an option	ITP	✔	✔	✔	33 ~ 34	Sweden
[OVC-HEV formula	Annex B8 4.2.2. others	provide calculation formula in the case of # of CD cycles is zero	TC	tbd	tbd	tbd	not ready yet	Japan]
Interpolation for PER	Annex B8 4.5.6.3. / 4.7. Table A8/10, A8/11	correct the calculation formula of PER values	TC	✔	✔	✔	35 ~ 46	OICA
OVC-FCHV	Annex B8 Table A6/1, A8/9a, A8/9b	apply also Level 1B	H	✔	✔	✔	47 ~ 59	Japan
Interpolation for (N)OVC-FCHV	Annex B8 4.5.5.1.4. Table A8/7	apply also Level 1B	H	✔	✔	✔	60 ~ 62	Japan
(N)OVC-FCHV range test	Annex B8 Appendix 1 Table A6/1, A8/12	newly developed the range test for OVC and NOVC-FCHV	NR	tbc	✔	✔	63 ~ 72	Japan
DF determination	Annex C4 7.	add unit for PN	EC	✔	✔	✔	73	Japan

* Purpose NR : New Requirement, H : Harmonisation
TC : Technical Correction, IPT : Improve Test Procedure EC : Editorial Correction

II. Text Proposals

<OBFCM>

5. Approval

5.11. ~~This paragraph is only applicable for Level 1A~~

Requirements for type-approval regarding devices for monitoring the consumption of fuel and/or electric energy

5.11.1. This paragraph is only applicable for Level 1A

The manufacturer shall ensure that the following vehicles of categories M_1, N_1 and N_2 are equipped with a device for determining, storing and making available data on the quantity of fuel and/or electric energy used for the operation of the vehicle:

(a) pure ICE and Not-Off-Vehicle Charging Hybrid Electric vehicles (NOVC-HEVs) powered exclusively by mineral diesel, biodiesel, petrol, ethanol or any combination of these fuels;

(b) Off-Vehicle Charging Hybrid Electric Vehicles (OVC-HEVs) powered by electricity and any of the fuels mentioned in point (a).

5.11.2. This paragraph is only applicable for Level 1B

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

(a) pure ICE and Not-Off-Vehicle Charging Hybrid Electric vehicles (NOVC-HEVs) powered exclusively by mineral diesel, biodiesel, petrol, ethanol or any combination of these fuels;

(b) Off-Vehicle Charging Hybrid Electric Vehicles (OVC-HEVs) powered by electricity and any of the fuels mentioned in point (a).

(c) NOVC-FCHV, PEV, CNG, LNG,,,,,

5.11.3. The device for monitoring the consumption of fuel and/or electric energy shall comply with the requirements laid down in Appendix 5.

6. Specifications and tests

6.2. Test procedure

Table A specifies the various test requirements for type approval of a vehicle.

Table A

Application of test requirements for type-approval and extensions

Vehicle category	*Vehicles with positive ignition engines including hybrids*[1,2]								*Vehicles with compression ignition engines including hybrids*		*Pure electric vehicles*	*Hydrogen fuel cell vehicles*
	Mono fuel				*Bi-fuel*[3]			*Flex-fuel*[3]	*Mono fuel*			
Reference fuel	Petrol	LPG	NG/ Biomethane	Hydrogen (ICE)	Petrol LPG	Petrol NG/ Biomethane	Petrol Hydrogen (ICE)[4]	Petrol Ethanol (E85)	Diesel	Petrol	—	Hydrogen (Fuel Cell)
Type 1 test (for applicability of measured components to fuels and vehicle technology and therefore measurement procedures, see Table 1A and Table 1B) (limits)	Yes	Yes[5]	Yes[5]	Yes[4]	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	—	—
ATCT (14°C test)	Yes	Yes	Yes	Yes[4]	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	—	—
Evaporative emissions (Type 4 test)	Yes	Yes [6]	Yes [6]	—	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	—	Yes	—	—
Durability (Type 5 test)	Yes	Yes	Yes	Yes	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes (petrol only)	Yes	Yes	—	—
OBD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	—
OBFCM	Yes	YES[7]—	YES[7]—	—	—	—	—	Yes (both fuels)	Yes	Yes	YES[7]—	YES[7]—

1 Specific test procedures for hydrogen vehicles will be defined at a later stage.

2 Particulate mass and particle number limits and respective measurement procedures shall apply only to vehicles with direct injection engines

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

4 Only NOx emissions shall be determined when the vehicle is running on hydrogen.

5 For Level 1A only - Particulate mass and particle number limits and respective measurement procedures shall not apply. For Level 1B only - In the case that a mono-fuel gas vehicle has a petrol tank it shall also be tested using the applicable petrol reference fuel

6 For Level 1B, if the mono-fuel gas vehicle does have a petrol tank "Yes", if the mono-fuel gas vehicle does not have a petrol tank "—", For Level 1A "—"

7 For Level 1B only

6.3.9. OBFCM

~~For Level 1A only:~~

The OBFCM device shall determine the parameters and store the lifetime values on board the vehicle in accordance to Appendix 5.

8. Conformity of production (COP)

8.1. Every vehicle produced under a type approval according to this Regulation shall conform with regard to the vehicle type approved. The conformity of production procedures shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3), with the following requirements:

8.1.1. The manufacturer shall implement adequate arrangements and documented control plans and carry-out, at intervals specified in this Regulation, the necessary tests to verify continued conformity with the approved type. The manufacturer shall obtain agreement for these arrangements and control plans from the responsible authority. The responsible authority shall perform audits at specific intervals. This audit shall include production and test facilities as part of the product conformity and continued verification arrangements. Where necessary the responsible authority may require additional tests to be conducted.

8.1.2. The manufacturer shall check the conformity of production by conducting the appropriate tests in accordance with Table 8/1 and Table 8/2 and with the OBD requirements, where applicable according to Table A in paragraph 6. Where applicable and if required according to Table A, the manufacturer shall determine and report the OBFCM device accuracy in accordance with Appendix 5.

The specific procedures for conformity of production are set out in paragraphs 8.2. to 8.4. and Appendices 1 to 4.

Table 8/1
Type 1 Applicable Type-1 CoP requirements for the different types of vehicle

Type of vehicle	*Criteria emissions*	*CO_2 emissions*	*Fuel Efficiency*	*Electric energy consumption*	*OBFCM accuracy*
Pure ICE	Level1A and Level 1B	Level 1A	Level 1B	Not Applicable	Level 1A
NOVC-HEV	Level 1A and Level 1B	Level 1A	Level 1B	Not Applicable	Level 1A
OVC-HEV	Level 1A and Level 1B: CD[(1)] and CS	Level 1A: CS only	Level 1B: CS only	Level1A and Level 1B: CD only	Level 1A : CS
PEV	Not Applicable	Not Applicable	Not Applicable	Level1A and Level 1B	Not Applicable
NOVC-FCHV	Not Applicable	Not Applicable	Exempted	Not Applicable	Not Applicable
OVC-FCHV	Not Applicable	Not Applicable	Exempted	Exempted	Not Applicable

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

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Appendix 2

Verification of conformity of production for Type 1 test—statistical method

3.4. ~~For Level 1A only:~~

For vehicles referred to in paragraph 5.11.1. and 5.11.2.excluding paragraph (c) of this Regulation the conformity of production of OBFCM devices as defined in paragraph 4.2. of Appendix 5 shall be evaluated as follows:

(1) For each single test i performed for the purposes of paragraph 3. of this appendix the value xi shall be set equal to:

1 / (1 - Accuracy)

where the Accuracy of the OBFCM device shall be determined in accordance with paragraph 4.2. of Appendix 5.

(2) The conformity of production of the OBFCM devices shall be evaluated according to the requirements of paragraph 3.3.1., but applying a factor A value of 1.0526.

(3) If for the last test N performed for the purposes of paragraph 3. the decision (iii) of paragraph 3.3.1. with regard to the conformity of production of the OBFCM

Commented [JPN_v12]: Under the discussion

Commented [JPN_v13]: Under the discussion

devices is reached, the sequence of tests shall be continued until a final decision (i) or (ii) of paragraph 3.3.1. is reached.

The Type Approval authority shall keep a record of the determined accuracies of OBFCM device at each test as well as the decision according to paragraph 3.3.1. after each test.

Appendix 5

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

~~Only applicable for Level 1A;~~

1. Introduction

This appendix sets out the definitions and requirements applicable to the devices for monitoring on board the vehicle the consumption of fuel and/or electric energy.

2. Definitions

2.1. "*On-board Fuel and/or Energy Consumption Monitoring Device*" ("OBFCM device") means any element of design, either software and/or hardware, which senses and uses vehicle, engine, fuel and/or electric energy parameters to determine and make available at least the information laid down in paragraph 3 of this appendix, and store the lifetime values on board the vehicle.

2.2. "*Lifetime*" value of a certain quantity determined and stored at a time *t* shall be the values of this quantity accumulated since the completion of production of the vehicle until time *t*.

2.3. "*Engine fuel rate*" means the amount of fuel injected into the engine per unit of time. It does not include fuel injected directly into the pollution control device.

2.4. "*Vehicle fuel rate*" means the amount of fuel injected into the engine and directly into the pollution control device per unit of time. It does not include the fuel used by a fuel operated heater.

2.5. "*Total Fuel Consumed (lifetime)*" means the accumulation of the calculated amount of fuel injected into the engine and the calculated amount of fuel injected directly into the pollution control device. It does not include the fuel used by a fuel operated heater.

2.6. "*Total Distance Travelled (lifetime)*" means the accumulation of the distance travelled using the same data source that the vehicle odometer uses.

2.7. "*Grid energy*" means, for OVC-HEVs, the electric energy flowing into the battery when the vehicle is connected to an external power supply and the engine is turned off. It shall not include electrical losses between the external power source and the battery.

2.8. "*Charge-sustaining operation*" means, for OVC-HEVs, the state of vehicle operation when the REESS state of charge (SOC) may fluctuate but the intent of the vehicle control system is to maintain, on average, the current state of charge.

2.9. "*Charge-depleting operation*" means, for OVC-HEVs, the state of vehicle operation when the current REESS SOC is higher than the charge-sustaining target SOC value and, while it may fluctuate, the intent of the vehicle control system is to deplete the SOC from a higher level down to the charge-sustaining target SOC value.

2.10. "*Driver-selectable charge-increasing operation*" means, for OVC-HEVs, the operating condition in which the driver has selected a mode of operation, with the intention to increase the REESS SOC.

2.11. "*Energy consumption rate*" means the amount of energy consumed for vehicle propulsion per unit of time.

2.12. "*Battery SOCE*" means the on-board usable battery energy (UBE) performance at a specific point in its lifetime, expressed as a percentage of the UBE determined during type approval testing.

2.13. "*Battery SOCR*" means the on-board electric range at a specific point in its lifetime, expressed as a percentage of the certified range.

3. Information to be determined, stored and made available

The OBFCM device shall determine at least the following parameters and store the lifetime values on board the vehicle. The parameters shall be calculated and scaled according the standards referred to in paragraph 6.5.3.2. (a) of Appendix 1 to Annex C5.

The information listed in paragraph 3.1. and 3.2. shall be made available as signals through the serial port connector referred to in paragraph 6.5.3.2. (c). of Appendix 1 to Annex C5.

3.1. For all vehicles referred to in paragraph 5.11. of this Regulation, with the exception of OVC-HEVs:

(a) Total fuel consumed (lifetime) (litres);

(b) Total distance travelled (lifetime) (kilometres);

(c) Engine fuel rate (grams/second);

(d) Engine fuel rate (litres/hour);

(e) Vehicle fuel rate (grams/second);

(f) Vehicle speed (kilometres/hour).

3.2. For OVC-HEVs:

(a) Total fuel consumed (lifetime) (litres);

(b) Total fuel consumed in charge-depleting operation (lifetime) (litres);

(c) Total fuel consumed in driver-selectable charge-increasing operation (lifetime) (litres);

(d) Total distance travelled (lifetime) (kilometres);

(e) Total distance travelled in charge-depleting operation with engine off (lifetime) (kilometres);

(f) Total distance travelled in charge-depleting operation with engine running (lifetime) (kilometres);

(g) Total distance travelled in driver-selectable charge-increasing operation (lifetime) (kilometres);

(h) Engine fuel rate (grams/second);

(i) Engine fuel rate (litres/hour);

(j) Vehicle fuel rate (grams/second);

(k) Vehicle speed (kilometres/hour);

(l) Total grid energy into the battery (lifetime) (kWh);

The following information are only applicable Level 1B

(m) Energy consumption rate per second (Wh/s) ;

(n) Battery SOCE (%) ;

(o) Battery SOCR (%)

3.3. For PEVs, applicable Level 1B only

(a) Total distance travelled (lifetime) (kilometres);

(b) Vehicle speed (kilometres/hour);

(c) Total grid energy into the battery (lifetime) (kWh);

(d) Energy consumption rate per second (Wh/s);

(e) Battery SOCE (%);

(f) Battery SOCR (%).

3.4. For NOVC-FCHVs, applicable Level 1B only

(a) Total fuel consumed (lifetime value) (kg);

(b) Total distance travelled (lifetime value) (km);

(c) Vehicle fuel consumption rate per second (g/s);

(d) Vehicle speed (km/h).

3.5. For OVC-FCHVs, applicable Level 1B only:

(a) Total fuel consumed (lifetime) (kgs);

(b) Total fuel consumed in charge-depleting operation (lifetime) (kgs);

(c) Total fuel consumed in driver-selectable charge-increasing operation (lifetime) (kgs);

(d) Total distance travelled (lifetime) (kilometres);

(e) Total distance travelled in charge-depleting operation with engine off (lifetime) (kilometres);

(f) Total distance travelled in charge-depleting operation with fuel-cell running (lifetime) (kilometres);

(g) Total distance travelled in driver-selectable charge-increasing operation (lifetime) (kilometres);

(h) Fuel-cell fuel rate (grams/second);

(i) Fuel-cell fuel rate (grams/hour);

(j) Vehicle fuel rate (grams/second);

(k) Vehicle speed (kilometres/hour);

(l) Total grid energy into the battery (lifetime) (kWh);

(m) Energy consumption rate per second (Wh/s) ;

3.~~5~~6. For CNG/LNG, applicable Level 1B only

(a) Total fuel consumed (lifetime) (m^3 or g);

(b) Total distance travelled (lifetime) (kilometres);

(c) Engine fuel rate (m^3 or g/second);

Commented [JPN_v14]: Since UNR154 doesn't define the UBE for OVC-HEV, it's up to each OEM how to define the SOCE for OVC-HEV.

Commented [JPN_v15]: Need to confirm each parameter (and unit)

(d) Engine fuel rate (m^3 or g/hour);

(e) Vehicle fuel rate (m^3 or g/second);

(f) Vehicle speed (kilometres/hour).

3.67. For all vehicles, applicable Level 1B only

(a) Vehicle identification number (VIN) prescribed in ISO 3779, chassis number or those equivalent to these

4. Accuracy

4.1. With regard to the information specified in paragraph 3., the manufacturer shall ensure that the OBFCM device provides the most accurate values that can be achieved by the measurement and calculation system of the engine control unit.

4.2. Notwithstanding paragraph 4.1., the manufacturer shall ensure that the accuracy is higher than - 0.05 and lower than 0.05 calculated with three decimals using the following formula:

$$\text{Accuracy} = \frac{\text{Fuel\_Consumed}_{\text{WLTP}} - \text{Fuel\_Consumed}_{\text{OBFCM}}}{\text{Fuel\_Consumed}_{\text{WLTP}}}$$

Where:

$\text{Fuel\_Consumed}_{\text{WLTP}}$ (litres)	is the fuel consumption determined at the first test carried out in accordance with paragraph 1.2. of Annex B6, calculated in accordance with paragraph 6. of Annex B7, using emission results over the total cycle before applying corrections (output of step 2 in Table A7/1 of Annex B7), multiplied by the actual distance driven and divided by 100.
$\text{Fuel\_Consumed}_{\text{OBFCM}}$ (litres)	is the fuel consumption determined for the same test using the differentials of the parameter 'Total fuel consumed (lifetime)' as provided by the OBFCM device.

For OVC-HEVs the charge-sustaining Type 1 test shall be used.

4.2.1. If the accuracy requirements set out in paragraph 4.2. are not met, the accuracy shall be recalculated for subsequent Type 1 tests performed in accordance with paragraph 1.2. of Annex B6, in accordance with the formulae in paragraph 4.2., using the fuel consumed determined and accumulated over all performed tests. The accuracy requirement shall be deemed to be fulfilled once the accuracy is higher than - 0.05 and lower than 0.05.

4.2.2. If the accuracy requirements set out in paragraph 4.2.1. are not met following the subsequent tests pursuant to this point, additional tests may be performed for the purpose of determining the accuracy, however, the total number of tests shall not exceed three tests for a vehicle tested without using the interpolation method (vehicle H), and six tests for a vehicle tested using the

interpolation method (three tests for vehicle H and three tests for vehicle L). The accuracy shall be recalculated for the additional subsequent Type 1 tests in accordance with the formulae in paragraph 4.2., using the fuel consumed determined and accumulated over all performed tests. The requirement shall be deemed to be fulfilled once the accuracy is higher than - 0.05 and lower than 0.05. Where the tests have been performed only for the purpose of determining the accuracy of the OBFCM device, the results of the additional tests shall not be taken into account for any other purposes.

5. Access to the information provided by the OBFCM device

5.1. The OBFCM device shall provide for standardised and unrestricted access of the information specified in paragraph 3. and shall conform to the standards referred to in paragraphs 6.5.3.1. (a) and 6.5.3.2. (a) of Appendix 1 to Annex C5.

5.2. By way of exemption from the reset conditions specified in the standards referred to in paragraph 5.1. and notwithstanding paragraphs 5.3. and 5.4., once the vehicle has entered into service the values of the lifetime counters shall be preserved.

5.3. The values of the lifetime counters may be reset only for those vehicles for which the memory type of the engine control unit is unable to preserve data when not powered by electricity. For those vehicles the values may be reset simultaneously only in the case the battery is disconnected from the vehicle. The obligation to preserve the values of the lifetime counters shall in this case apply for new type approvals at the latest from 1 January 2022 and for new vehicles from 1 January 2023.

5.4. In the case of malfunctioning affecting the values of the lifetime counters, or replacement of the engine control unit, the counters may be reset simultaneously to ensure that the values remain fully synchronised.

5.5. This paragraph is only applicable Level 1B

In cases where the lifetime values are no longer preserved, the fact that they are no longer preserved shall be recorded in the ECU and the record concerned shall not be deleted easily.

Annex A1 - Appendix 1

WLTP Test Report

Commented [JPN_v16]: Need to be updated

Test Reports

Annex B6

Type 1 test procedures and test conditions

2.6.8.5. OBFCM data recording and storing

During the Type 1 test, the following parameters referred in Appendix 5 of this Regulation shall be recorded and saved (1 Hz sampling frequency) by the testing lab and shall be made available by the approval authority if requested by a regional authority:

(a) Engine fuel rate (grams/second);

(b) Engine fuel rate (litres/hour);

(c) Vehicle fuel rate (grams/second).

Commented [JPN_v17]: Currently exempted in our regional regulation.
Under the consideration

<OVC-HEV Family definition >

***Paragraph 6.3.2.2.*, amend to read**:

6. Specifications and tests

6.3.2.2. Interpolation family for NOVC-HEVs and OVC-HEVs

In addition to the requirements of paragraph 6.3.2.1., only OVC-HEVs and NOVC-HEVs that are identical with respect to the following characteristics may be part of the same interpolation family:

(c) Type of electric energy converter between the electric machine and traction REESS, between the traction REESS and low voltage power supply and between the recharge-plug-in and traction REESS, and any other characteristics having a non-negligible influence on CO_2 emission and electric energy consumption under WLTP conditions. At the request of the manufacturer and with the approval of the approval authority, electric energy converters between recharge-plug-in and traction REESS with lower recharge losses may be included in the family;

For level 1A only

(d) The difference between the number of charge-depleting cycles from the beginning of the test up to and including the transition cycle shall not be more than one.

Commented [JAMA8]: delete (d) from Level 1B

***Paragraph 4.1.2.* Annex B8, amend to read:**

4.1.2. Charge-depleting CO_2 emission for OVC-HEVs

For Level 1A:

The utility factor-weighted charge-depleting CO_2 emission $M_{CO2,CD}$ shall be calculated using the following equation:

$$M_{CO2,CD} = \frac{\sum_{j=1}^{k}(UF_j \times M_{CO2,CD,j})}{\sum_{j=1}^{k} UF_j}$$

~~**For Level 1B**~~

~~**The charge-depleting CO_2 emission $M_{CO2,CD}$ shall be calculated using the following equation:**~~

~~$$M_{CO2,CD} = \frac{\sum_{j=1}^{k}(M_{CO2,CD,j} \times d_j)}{\sum_{j=1}^{k} d_j}$$~~

Table A8/8 Annex B8, amend to read:
Calculation of final charge-depleting values (FE applicable for Level 1B only)

Step no.	*Source*	*Input*	*Process*	*Output*
For Level 1A 10	Output step 1	$M_{CO2,CD,j}$, g/km; K_{CO2}, (g/km)/(Wh/km); $\Delta E_{REESS,j}$, Wh; d_j, km; ~~**n_{veh};**~~ ~~**$n_{veh,L}$;**~~ ~~**$UF_{phase,j}$;**~~	Calculation of the charge-depleting CO_2 emission according to paragraph 4.1.2. of this annex. In the case that the interpolation method is applied, $n_{veh,L}$ cycles shall be used. With reference to paragraph 4.1.2. of this annex, the confirmation cycle shall be corrected according to Appendix 2 to this annex. Output is available for each test.	$M_{CO2,CD}$, g/km;
	Output step 3	~~d_j, km;~~ **n_{veh};**		
	Output step 4	~~n_{veh};~~ **$n_{veh,L}$;**		
	Output step 8	~~$n_{veh,L}$;~~ **$UF_{phase,j}$.**		
11	Output step 1	$M_{CO2,CD,j}$, g/km; $M_{i,CD,j}$, g/km; K_{CO2}, (g/km)/(Wh/km). ~~**n_{veh};**~~ ~~**$n_{veh,L}$;**~~ ~~**$UF_{phase,j}$;**~~	Calculation of the charge-depleting fuel consumption and fuel efficiency according to paragraph 4.2.2. of this annex. In the case that the interpolation method is applied, $n_{veh,L}$ cycles shall be used. With reference to paragraph 4.1.2. of this annex, $M_{CO2,CD,j}$ of the confirmation cycle shall be corrected according to Appendix 2 to this annex. For Level 1A, the phase-specific fuel consumption $FC_{CD,j}$ shall be calculated using the corrected CO_2 emission according to paragraph 6. of Annex B7. Output is available for each test.	For Level 1A, $FC_{CD,j}$, l/100 km; FC_{CD}, l/100 km. For Level 1B, FE_{CD}, km/l.
	Output step 3	n_{veh};		
	Output step 4	$n_{veh,L}$;		
	Output step 8	$UF_{phase,j}$;		

II. Justification

1. Level 1B Family requirements have no effect on (d) requirement existence or non-existence for linearity of EC and EAER with respect to cycle energy demand.

<Interpolation family definition>

<Level 1 - Even series>

6.3.2.2. Interpolation family for NOVC-HEVs and OVC-HEVs

(b) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

6.3.2.3. Interpolation family for PEVs

(b) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

6.3.2.4. Interpolation family for OVC-FCHVs and NOVC-FCHVs

(c) Type of traction REESS (type of cell~~model~~, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

<Level 2 - Odd series>

6.3.2.2. Interpolation family for NOVC-HEVs and OVC-HEVs

(b) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

6.3.2.3. Interpolation family for PEVs

(b) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

6.3.2.4. Interpolation family for OVC-FCHVs and NOVC-FCHVs

(c) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

<OBD text>

<Level 1 - Even series>

6.8.2. OBD thresholds

The OBD thresholds referred to in Annex C5 are specified in Table 4A ~~and~~ or Table 4B.

Table 4A

This table is only applicable for Level 1A

OBD thresholds

Table 4B

This table is only applicable for Level 1B

OBD thresholds

<Level 2 - Odd series>

6.8.2. OBD thresholds

The OBD thresholds referred to in Annex C5 are specified in Table 4A and Table 4B.

Table 4A

OBD thresholds for the Type 1 test which apply to the emissions from the 4 phases of a WLTP test

Table 4B

OBD thresholds for the Type 1 test which apply to the emissions from the first 3 phases of a WLTP test

Reference – for emission limit -

<Level 1 - Even series>

6.3.10. Limits for gaseous emissions and the mass of particulates and number of particles

The resulting masses of gaseous emissions and the mass of particulates and number of particles obtained shall be less than the limits shown in Table 1A (for Level 1A) **or** Table 1B (for Level 1B):

<Level 2 - Odd series>

6.3.10. Limits for gaseous emissions and the mass of particulates and number of particles

The resulting masses of gaseous emissions and the mass of particulates and number of particles obtained shall be less than the limits shown in Table 1A **and** Table 1B (as applicable):

Table 1A
Emissions limits for the Type 1 test which apply to the emissions from the 4 phases of a WLTP test

Table 1B
Emissions limits for the Type 1 test which apply to the emissions from the first 3 phases of a WLTP test

<Inducement System>

Appendix 6

Requirements for vehicles that use a reagent for the exhaust after-treatment system

8. Driver inducement system

8.1. ~~The vehicle shall include a driver inducement system to ensure that the vehicle operates with a functioning emission control system at all times.~~ The inducement system shall be designed so as to ensure that the vehicle cannot continue to operate~~e~~ if the abnormality in the reagent dosing is not rectified~~under the conditions described in the paragraph 8.2. of this appendix with an empty reagent tank.~~

8.1.1. The requirement for a driver inducement system shall not apply to vehicles designed and constructed for use by the rescue services, armed services, civil defence, fire services and forces responsible for maintaining public order. Permanent deactivation of the driver inducement system for these vehicles shall only be done by the vehicle manufacturer.

8.2. The inducement system shall activate at the latest when the level of reagent in the tank reaches:

(a) In the case that the warning system was activated at least 2,400 km before the reagent tank was expected to become empty, a level expected to be sufficient for driving the average driving range of the vehicle with a complete tank of fuel;

(b) In the case that the warning system was activated at the level described in paragraph 3.5.(a), a level expected to be sufficient for driving 75 per cent of the average driving range of the vehicle with a complete tank of fuel;

(c) In the case that the warning system was activated at the level described in paragraph 3.5.(b), 5 per cent of the capacity of the reagent tank;

(d) In the case that the warning system was activated ahead of the levels described in both paragraph 3.5.(a) and 3.5.(b) but less than 2,400 km in advance of the reagent tank becoming empty, whichever level described in (b) or (c) of this paragraph occurs earlier.

Where the alternative described in paragraph 6.1. is utilised, the system shall activate when the irregularities described in paragraphs 4. or 5. or the NOx levels described in paragraph 6.2. have occurred.

The detection of an empty reagent tank and the irregularities mentioned in paragraphs 4., 5., or 6. shall result in the failure information storage requirements of paragraph 7. taking effect.

Commented [JPN9]: This paragraph misleads that inducement system should be activated whenever malfunction of emission control system is detected.

Commented [JPN10]: This paragraph misleads that inducement system should be activated only when the reagent tank is empty

<PEV Test Cycle Classification>

***Table A4/3 Annex B4, amend to read*:**

Table A4/3
Warming-up and stabilization across phases (as applicable)

Cycle class	*Applicable WLTC*	*90 per cent of maximum speed*	*Next higher phase*
Class 1	Low_1 + $Medium_1$ + **Low_1**	58 km/h	NA
Class 2	Low_2 + $Medium_2$ + $High_2$ + Extra $High_2$	111 km/h	NA
	Low_2 + $Medium_2$ + $High_2$	77 km/h	Extra High (111 km/h)
Class 3	Low_3 + $Medium_3$ + $High_3$ + Extra $High_3$	118 km/h	NA
	Low_3 + $Medium_3$ + $High_3$	88 km/h	Extra High (118 km/h)

***Table A4/7 Annex B4, amend to read*:**

Table A4/7 Vehicle warm-up

Vehicle class	*Applicable WLTC*	*Adopt next higher phase*	*Warm-up cycle*
Class 1	Low_1+ $Medium_1$ + **Low_1**	NA	Low_1+ $Medium_1$ + **Low_1**
Class 2	Low_2 + $Medium_2$ + $High_2$ + Extra $High_2$	NA	Low_2 + $Medium_2$ + $High_2$ + Extra $High_2$
	Low_2 + $Medium_2$ + $High_2$	Yes (Extra $High_2$)	
		No	Low_2+ $Medium_2$+ $High_2$
Class 3	Low_3 + $Medium_3$ + $High_3$ + Extra $High_3$	Low_3 + $Medium_3$ + $High_3$ + Extra $High_3$	Low_3 + $Medium_3$ + $High_3$ + Extra $High_3$
	Low_3 + $Medium_3$ + $High_3$	Yes (Extra $High_3$)	
		No	Low_3 + $Medium_3$ + $High_3$

***Paragraph 3.7.1.*, amend to read:**

3.7.1.

"*Rated engine power*" (P_{rated}) means maximum net power of the engine or motor in kW as per the requirements of UN Regulation No. 85 or system power as per the requirement of UN Regulation No. 177[if applicable].

***Paragraph 6.3.2.3.*, amend to read:**

6. Specifications and tests

6.3.2.3. Interpolation family for PEVs

6.3.2.3.1. This paragraph is only applicable for 3-phase WLTP test

Vehicles may be part of the same interpolation family in any of the following cases including combinations of these cases:

(a) They belong to different vehicle classes as described in paragraph 2. of Annex B1;

(b) They have different levels of downscaling as described in paragraph 8. of Annex B1 ;

(c) They have different capped speeds as described in paragraph 9. of Annex B1.

Commented [TY(就11]: Apply same provision as ICE to PEV

6.3.2.3.**2.** Only PEVs that are identical with respect to the following electric powertrain/transmission characteristics may be part of the same interpolation family:

(a) Type and number of electric machines: construction type (asynchronous/ synchronous, etc.), type of coolant (air, liquid) and any other characteristics having a non-negligible influence on electric energy consumption and range under WLTP conditions;

(b) Type of traction REESS (type of cell, capacity, nominal voltage, nominal power, type of coolant (air, liquid));

(c) Transmission type (e.g. manual, automatic, CVT) and transmission model (e.g. torque rating, number of gears, numbers of clutches, etc.);

(d) Number of powered axles;

(e) Type of electric energy converter between the electric machine and traction REESS, between the traction REESS and low voltage power supply and between the recharge-plug-in and traction REESS, and any other characteristics having a non-negligible influence on electric energy consumption and range under WLTP conditions. At the request of the manufacturer and with the approval of the approval authority, electric energy converters between recharge-plug-in and traction REESS with lower recharge losses may be included in the family;

(f) Operation strategy of all components influencing the electric energy consumption within the powertrain;

(g) n/v ratios (engine rotational speed divided by vehicle speed). This requirement shall be considered fulfilled if, for all transmission ratios concerned, the difference with respect to the n/v ratios of the most commonly installed transmission type and model is within 8 per cent.

Paragraph 2.3.2. Annex B1, amend to read:

2.3.2. **~~For 4-phase WLTP test~~**

All vehicles tested according to Annex B8 shall be considered to be Class 3 vehicles.

For 3-phase WLTP test only

At the request of the manufacturer and with approval of the responsible authority, PEVs may be classified according to paragraphs 2.1. to 2.3.1.2. replacing the rated power with maximum net power according to Regulation No. 85 or peak power according to Global Technical Regulation No.21 **~~All vehicles tested according to Annex B8 shall be considered to be Class 3 vehicles except PEVs.~~**

Paragraph 1.4. Annex B8, amend to read:

1. General requirements

1.4. Vehicle classification

~~For 4-phase WLTP test~~

~~All OVC HEVs, NOVC HEVs, PEVs, OVC FCHVs and NOVC FCHVs shall be classified as Class 3 vehicles.~~

~~For 3-phase WLTP test~~

~~All OVC HEVs, NOVC HEVs and NOVC FCHVs shall be classified as Class 3 vehicles.~~

~~For 4-phase WLTP test and 3-phase WLTP test~~

Vehicle classification is defined according to paragraph 2. of Annex B1.

The applicable test cycle for the Type 1 test procedure shall be determined according to paragraph 1.4.2. of this annex based on the corresponding reference test cycle as described in paragraph 1.4.1. of this annex.

1.4.1.1. Vehicle classification

The ~~Class 3~~ reference test cycles are specified in paragraph 3.~~3.~~ of Annex B1.

Paragraph 3.4.1. Annex B8, amend to read:

3.4. PEVs

3.4.1. General requirements

The test procedure to determine the pure electric range and electric energy consumption shall be selected according to the estimated pure electric range (PER) of the test vehicle from Table A8/3. In the case that the interpolation method is applied, the applicable test procedure shall be selected according to the PER of vehicle H within the specific interpolation family.

Table A8/3
Procedures to determine pure electric range and electric energy consumption (as applicable)

Applicable test cycle	*The estimated PER is…*	*Applicable test procedure*
Test cycle according to paragraph 1.4.2.1. of this annex including the extra high phase.	…less than the length of 3 applicable WLTP test cycles.	Consecutive cycle Type 1 test procedure (according to paragraph 3.4.4.1. of this annex).
	… equal to or greater than the length of 3 applicable WLTP test cycles.	Shortened Type 1 test procedure (according to paragraph 3.4.4.2. of this annex).
Test cycle according to paragraph 1.4.2.1. of this annex excluding the extra high phase.	…less than the length of 4 applicable WLTP test cycles.	Consecutive cycle Type 1 test procedure (according to paragraph 3.4.4.1. of this annex).
	…equal to or greater than the length of 4 applicable WLTP test cycles.	Shortened Type 1 test procedure (according to paragraph 3.4.4.2. of this annex).
City cycle according to paragraph 1.4.2.2. of this annex.	…not available over the applicable WLTP test cycle.	Consecutive cycle Type 1 test procedure (according to paragraph 3.4.4.1. of this annex).

The manufacturer shall give evidence to the responsible authority concerning the estimated pure electric range (PER) prior to the test. In the case that the interpolation method is applied, the applicable test procedure shall be determined based on the estimated PER of vehicle H of the interpolation family. The PER determined by the applied test procedure shall confirm that the correct test procedure was applied.

The test sequence for the consecutive cycle Type 1 test procedure, as described in paragraphs 3.4.2., 3.4.3. and 3.4.4.1. of this annex, as well as the corresponding REESS state of charge profile, are shown in Figure A8.App1/6 of Appendix 1 to this annex.

The test sequence for the shortened Type 1 test procedure, as described in paragraphs 3.4.2., 3.4.3. and 3.4.4.2. of this annex as well as the corresponding REESS state of charge profile, are shown in Figure A8.App1/7 in Appendix 1 to this annex.

For 3-phase WLTP test

In the case that the test vehicle was classified as Class 1 or Class 2, the Consecutive cycle Type 1 test procedure shall be selected.

II. Justification

1. Proposal for amendments of editorial error of class 1 applicable WLTP cycle.
2. Proposal for get the appropriate pure electric range result of low power PEVs.

<Run-in procedure>

Paragraph 4.2.1.8.1. **Annex B4, amend to read:**

4.2.1.8.1. Run-in

The test vehicle shall be suitably run-in for the purpose of the subsequent test for at least 10,000 but no more than 80,000 km.

At the request of the manufacturer, a vehicle with a minimum of 3,000 km may be used.

In case of PEVs, NOVC-FCHVs and OVC-FCHVs at the request of the manufacturer, a vehicle with a minimum of 300 km may be used.

Commented [JAMA12]: PEV/NOVC-FCHV/OVC-FCHV の R/L 測定車慣らし走行距離を FCHV 燃費測定車と同条件でも可とする。

<Speed Trace Tolerance>

2.6.8.3. Speed trace tolerances

Vehicles that cannot attain the acceleration and maximum speed values required in the applicable WLTC shall be operated with the accelerator control fully activated until they once again reach the required speed trace. Speed trace violations under these circumstances shall not void a test. Deviations from the driving cycle shall be recorded.

2.6.8.3.1. Unless otherwise stated in the specific sections, the following tolerances shall be permitted between the actual vehicle speed and the prescribed speed of the applicable test cycles based on the driving events:

2.6.8.3.1.1. Tolerance (1)

(a) Upper limit: 2.0 km/h higher than the highest point of the trace within ±5.0 second of the given point in time;

(b) Lower limit: 2.0 km/h lower than the lowest point of the trace within ±5.0 second of the given time.

2.6.8.3.1.2. Tolerance (2)

Speed tolerances greater than those prescribed shall be accepted provided the tolerances are never exceeded for more than 1 second on any one occasion. There shall be no more than ten such deviations per test cycle.

(a) Upper limit: 2.0 km/h higher than the highest point of the trace within ±1.0 second of the given point in time;

(b) Lower limit: 2.0 km/h lower than the lowest point of the trace within ±1.0 second of the given time.

~~(i) Speed tolerances greater than those prescribed shall be accepted provided the tolerances are never exceeded for more than 1 second on any one occasion.~~

~~(ii) There shall be no more than ten such deviations per test cycle.~~

< Cycle Energy Demand for PEV >

In the 04 Series of Amendments,

Paragraph 2, amend to read:

2. Abbreviations

2.1. General abbreviations

CED	**Cycle energy demand, considering positive cycle energy**
CED_{REESS}	**Cycle energy demand REESS, considering positive *and* negative cycle energy**

Paragraph 3, amend to read:

3. Definitions

3.5.5. **"*Cycle energy demand REESS (CED_{REESS})*" means the calculated positive and negative energy required by the vehicle REESS to drive the prescribed cycle**

Paragraph 5. of Annex B7, amend to read:

5 Calculation of cycle energy demand **(CED)**

Appendix 9 of Annex B8, new to read:

Calculation of cycle energy demand REESS (CED_{REESS})

Unless otherwise specified, the calculation shall be based on the target speed trace given in discrete time sample points.

The total energy demand E for the whole cycle or a specific cycle phase shall be calculated by summing E_i over the corresponding cycle time between t_{start} +1 and t_{end} according to the following equation:

$$E = \sum_{t_{start+1}}^{t_{end}} E_i$$

where:

$$E_i = \frac{F_i \times d_i}{\eta_T} \quad \text{if } F_i > 0$$

$$E_i = F_i \times d_i \times \eta_R \quad \text{if } F_i \leq 0$$

and:

t_{start}	**is the time at which the applicable test cycle or phase starts (see paragraph 3. of Annex B1), s;**
t_{end}	**is the time at which the applicable test cycle or phase ends (see paragraph 3. of Annex B1), s;**
E_i	**is the energy demand during time period (i-1) to (i), Ws;**
F_i	**is the driving force during time period (i-1) to (i), N;**
d_i	**is the distance travelled during time period (i-1) to (i), m.**

$$F_i = f_0 + f_1 \times \left(\frac{v_i + v_{i-1}}{2}\right) + f_2 \times \frac{(v_i + v_{i-1})^2}{4} + (1.03 \times TM) \times a_i$$

where:

F_i **is the driving force during time period (i-1) to (i), N;**

v_i **is the target velocity at time t_i, km/h;**

TM **is the test mass, kg;**

a_i **is the acceleration during time period (i-1) to (i), m/s²;**

f_0, f_1, f_2 **are the road load coefficients for the test vehicle under consideration (TM_L , TM_H or TM_{ind}) in N, N/km/h and in N/(km/h)² respectively.**

η_R **is the average recuperation efficiency for electric energy transfer from the wheel into the battery in the applicable WLTP test cycle and WLTP City test cycle. A default value of [0.85] shall be used.**

η_T **is the average traction efficiency for electric energy transfer from the battery to the wheel in the applicable WLTP test cycle and WLTP City test cycle. A default value of [0.90] shall be used.**

Paragraph 4.5.2. of Annex B8, amend to read:

4.5.2.**1** Calculation of **cycle** energy demand **(CED)** per period

The energy demand $E_{k,p}$ and distance driven $d_{c,p}$ per period p applicable for individual vehicles in the interpolation family shall be calculated according to the procedure in paragraph 5 of Annex B7 for the sets k of road load coefficients and masses according to paragraph 3.2.3.2.3. of Annex B7.

4.5.2.2 **Calculation of cycle energy demand REESS (CED_{REESS}) per period for PEVs**

The energy demand $E_{k,p}$ and distance driven $d_{c,p}$ per period p applicable for the calculation of electric energy consumption and pure electric range of individual vehicles in the interpolation family shall be calculated according to the procedure in Appendix 9 of Annex B8.

Paragraph 4.5.3. of Annex B8, amend to read:

4.5.3.**1** Calculation of the interpolation coefficient for individual vehicles $K_{ind,p}$ **for OVC-HEVs and OVC-FCHVs**

The interpolation coefficient $K_{ind,p}$ per period shall be calculated for each considered period p using the following equation:

$$K_{ind,p} = \frac{E_{3,p} - E_{1,p}}{E_{2,p} - E_{1,p}}$$

where:

$K_{ind,p}$ is the interpolation coefficient for the considered individual vehicle for period p;

$E_{1,p}$ is the energy demand for the considered period for vehicle L according to paragraph 5 of Annex B7, Ws;

$E_{2,p}$ is the energy demand for the considered period for vehicle H according to paragraph 5 of Annex B7, Ws;

$E_{3,p}$ is the energy demand for the considered period for the individual vehicle according to paragraph 5 of Annex B7, Ws;

p is the index of the individual period within the applicable test cycle.

In the case that the considered period p is the applicable WLTP test cycle, $K_{ind,p}$ is named K_{ind}.

4.5.3.2 Calculation of the interpolation coefficient for individual vehicles $K_{ind,p}$ for PEVs

The interpolation coefficient $K_{ind,p}$ per period shall be calculated for each considered period p using the following equation:

$$\mathbf{K_{ind,p} = \frac{E_{3,p} - E_{1,p}}{E_{2,p} - E_{1,p}}}$$

where:

$K_{ind,p}$ is the interpolation coefficient for the considered individual vehicle for period p;

$E_{1,p}$ is the energy demand for the considered period for vehicle L according to Appendix 9 of Annex B8, Ws;

$E_{2,p}$ is the energy demand for the considered period for vehicle H according to Appendix 9 of Annex B8, Ws;

$E_{3,p}$ is the energy demand for the considered period for the individual vehicle according to Appendix 9 of Annex B8, Ws;

p is the index of the individual period within the applicable test cycle.

In the case that the considered period p is the applicable WLTP test cycle, $K_{ind,p}$ is named K_{ind}.

II. Justification

Currently the cycle energy demand in the WLTC is exclusively calculated based on the driving force Fi > 0 (Paragraph 5 of Annex B7). Consequentially the actual electric consumption of individual vehicles with identical cycle energy can vary, depending on the physics determining the respective road load (e.g. high TM, low RR, low aero drag vs. low TM, high RR, high aero drag).

The recuperated energy has an essential influence on the electric consumption in PEVs. Due to that fact it should be accounted for in the calculation of the cycle energy in individual vehicles. This will allow more accurate interpolated EC and PER values for individual vehicle configurations compared to respective measured values.

<Robot Driver>

Since the test procedure can be performed by either a driver, or an operator, one option is to perform the test procedure with a driver robot as the operator.

The proposal is to allow the possibility to use a driver robot as the operator in the test procedure to determine pure electric range, and electric energy consumption. One key criteria is that the robot will have to act as a human driver and the request for acceleration and deceleration will have to come from an external source, vehicle speed from the test cell equipment. It shall not be allowed to drive the vehicle through the vehicle internal ECUs, the vehicle speed request shall come from an external source outside the vehicle.

The intention is to enable efficient and correct tests related to pure electric range and electric energy consumption test procedures. It should be possible to use both a mechanical robot and a virtual robot, however always to perform the test replicating a human driver.

Correlation tests between a human driver and the driver robot will have to be demonstrated to the approval authority to show that the robot acts as a human driver.

I. Proposal

Add new paragraph to the end of Section 3.4.1 in Annex B8

On request by the manufacturer and approved by the type approval authority the test can be operated by a mechanical robot. The robot shall be an external device that replicates a human driver. Using the same actuators as the human driver would use, that is the accelerator pedal and the brake pedal [and any other controls needed to operate the vehicle]. The type approval authority shall request the manufacturer to demonstrate correlation that the robot acts as a human driver.

II. Justification

The procedure to determine the pure electric range and the electric energy consumption is presented in table A8/3 of Annex B8. The procedure is either to perform consecutive Type I test procedures, or a shortened Type I test procedure where two dynamic segments are combined with two constant speed segments.

The complete pure electric range demonstration is very time consuming (usually more, or lot more, than 6 hours), and one driver will not be able to run the complete procedure without taking one or more breaks. The test procedure as defined in section 3.4.4 of Annex B8 allows one or more shorter breaks during the test procedure. However, a mistake by the driver, does not manage to follow the vehicle speed trace or exceeding the maximum driver break time will disqualify the test. As a result the test procedure will have to be re-started with conditioning of the test vehicle and REESS.

Improved and/or new technology with improved pure electric range will result in even longer time for a complete pure electric range test. As a result the consequences by failing the test procedure boundaries will have an even more negative impact on the total time to complete the test procedure.

The procedure can be performed by either a driver, or an operator. One option with regards to an operator is to perform the test procedure with driver robots. Where it is important that the robot acts as a human driver.

A human driver is using the accelerator pedal to request acceleration, and the brake pedal to request deceleration. In addition, the vehicle speed trace to be followed by the driver during test sequence is presented to the driver on a screen in front of the vehicle. Information with regards to vehicle speed serves as the information for the driver to either accelerate, or decelerate the vehicle in order to accurately follow the speed trace. The request for acceleration, or deceleration is made through actuators, the accelerator pedal and brake

pedal, where the pedal position signals are sent to a vehicle ECU. The ECU then request a specific torque and engine speed based on the received information from the accelerator or brake pedal position signals.

For a robot to act as a human driver it is important to secure that the robot receives input for decisions, the vehicle speed information, to request acceleration or deceleration from outside the vehicle. Since the human driver is using the vehicle speed trace as the major information to decide if to request acceleration or deceleration, it is appropriate to have the vehicle speed information as the main input also for a robot.

There are solutions available to provide the vehicle speed to ~~either~~ a physical/mechanical robot. ~~:~~

A mechanical robot is a hardware installed in a vehicle with actuators connected to acceleration pedal, brake pedal, gear selection, etc. The robot shall use the vehicle speed signal information from the test cell as the primary input with the purpose to follow the vehicle speed trace.

In addition, for autonomous vehicles there will not necessarily be actuators to be used by a human driver, and hence external signals will be required to perform tests.

< Interpolation for PER >

Paragraph 4.5.6.3. of Annex B8, for context information

"4.5.6.3. Individual electric energy consumption for OVC-HEVs and PEVs

The electric energy consumption for an individual vehicle according to paragraph 4.3.3. of this annex in the case of OVC-HEVs and according to paragraph 4.3.4. of this annex in the case of PEVs shall be calculated using the following equation:

$$EC_{ind,p} = EC_{L,p} + K_{ind,p} \times \left(EC_{H,p} - EC_{L,p}\right)$$

where:

$EC_{ind,p}$ is the electric energy consumption for an individual vehicle for the considered period p, Wh/km;

$EC_{L,p}$ is the electric energy consumption for vehicle L for the considered period p, Wh/km;

$EC_{H,p}$ is the electric energy consumption for vehicle H for the considered period p, Wh/km;

$K_{ind,p}$ is the interpolation coefficient for the considered individual vehicle for period p according to paragraph 4.5.3. of this annex;

p is the index of the individual period within the applicable test cycle.

For the 4-phase WLTP;

The considered periods shall be the low phase, medium phase, high phase, extra high phase, the applicable WLTP city test cycle and the applicable WLTP test cycle.

For the 3-phase WLTP;

The considered periods shall be the low phase, medium phase, high phase and the applicable WLTP test cycle.

Paragraph 4.5.7.2 of Annex B8. for context information

"4.5.7.2. Individual pure electric range for PEVs

The pure electric range for an individual vehicle shall be calculated using the following equation:

$$\boldsymbol{PER_{ind,p} = \frac{1}{\left(\frac{1}{PER_{L,p}} + K_{ind,p} \times \left(\frac{1}{PER_{H,p}} - \frac{1}{PER_{L,p}}\right)\right)}}$$

where:

$PER_{ind,p}$ is the pure electric range for an individual vehicle for the considered period p, km;

$PER_{L,p}$ is the pure electric range for vehicle L for the considered period p, km;

$PER_{H,p}$ is the pure electric range for vehicle H for the considered period p, km;

$K_{ind,p}$ is the interpolation coefficient for the considered individual vehicle for period p according to paragraph 4.5.3. of this annex;

p is the index of the individual period within the applicable test cycle.

For the 4-phase WLTP only;

The considered periods shall be the low phase, medium phase, high phase, extra high phase, the applicable WLTP city test cycle and the applicable WLTP test cycle.

For the 3-phase WLTP only;

The considered periods shall be the applicable WLTP test cycle.

Paragraph 4.7 of Annex B8, amend to read, for context information

"4.7. Stepwise procedure for calculating the final test results of PEVs

The results shall be calculated in the order described in Table A8/10 of the consecutive cycle procedure and in the order described in Table A8/11 in the case of the shortened test procedure. All applicable results in the column "Output" shall be recorded. The column "Process" describes the paragraphs to be used for calculation or contains additional calculations.

4.7.1. Stepwise procedure for calculating the final test results of PEVs in case of the consecutive cycles procedure

For the purpose of this table, the following nomenclature within the questions and results is used:

j index for the considered period.

Table A8/10

Calculation of final PEV values determined by application of the consecutive cycle Type 1 procedure

Table A8/10 shall be performed separately for results after 4 phases and for results after 3 phases.

For results after 4 phases;

The considered periods shall be the low phase, medium phase, high phase, extra high phase, the applicable WLTP city test cycle and the applicable WLTP test cycle.

For results after 3 phases;

The considered periods shall be the low phase, medium phase, high phase and the applicable WLTP test cycle.

Step no.	*Source*	*Input*	*Process*	*Output*
1	Annex B8	Test results	Results measured according to Appendix 3 to this annex and pre-calculated according to paragraph 4.3. of this annex. Usable battery energy according to paragraph 4.4.2.2.1. of this annex. Recharged electric energy according to paragraph 3.4.4.3. of this annex. Output is available for each test. E_{AC} shall be rounded according to paragraph 6.1.8. of this Regulation to the first place of decimal.	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{CCP}, Wh; E_{AC}, Wh.
2	Output step 1	$\Delta E_{REESS,j}$, Wh; UBE_{CCP}, Wh.	Determination of the number of completely driven applicable WLTC phases and cycles according to paragraph 4.4.2.2. of this annex. Output is available for each test.	n_{WLTC}; n_{city}; n_{low}; n_{med}; n_{high}; n_{exHigh}.

Step no.	*Source*	*Input*	*Process*	*Output*
3	Output step 1	$\Delta E_{REESS,j}$, Wh; UBE_{CCP}, Wh.	Calculation of weighting factors according to paragraph 4.4.2.2. of this annex. *Note*: The number of weighting factors depends on the applicable cycle that was used (3- or 4-phase WLTC). In the case of 4-phase WLTCs, the output in brackets might be needed in addition. Output is available for each test.	$K_{WLTC,1}$ $K_{WLTC,2}$ $K_{WLTC,3}$ ($K_{WLTC,4}$) $K_{city,1}$ $K_{city,2}$ $K_{city,3}$ ($K_{city,4}$) $K_{low,1}$ $K_{low,2}$ $K_{low,3}$ ($K_{low,4}$) $K_{med,1}$ $K_{med,2}$ $K_{med,3}$ ($K_{med,4}$) $K_{high,1}$ $K_{high,2}$ $K_{high,3}$ ($K_{high,4}$) $K_{exHigh,1}$ $K_{exHigh,2}$ $K_{exHigh,3}$ ($K_{exHigh,4}$)
4	Output step 1	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{CCP}, Wh.	Calculation of electric energy consumption at the REESSs according to paragraph 4.4.2.2. of this annex. Calculation of the electric energy consumption from the first applicable WLTP test cycle $EC_{DC,first}$. Output is available for each test.	$EC_{DC,WLTC}$, Wh/km; $EC_{DC,city}$, Wh/km; $EC_{DC,low}$, Wh/km; $EC_{DC,med}$, Wh/km; $EC_{DC,high}$, Wh/km; $EC_{DC,exHigh}$, Wh/km; $EC_{DC,first}$, Wh/km.
	Output step 2	n_{WLTC}; n_{city}; n_{low}; n_{med}; n_{high}; n_{exHigh}.		
	Output step 3	All weighting factors		
5	Output step 1	UBE_{CCP}, Wh;	Calculation of pure electric range according to paragraph 4.4.2.2. of this annex. Output is available for each test.	PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km.
	Output step 4	$EC_{DC,WLTC}$, Wh/km; $EC_{DC,city}$, Wh/km; $EC_{DC,low}$, Wh/km; $EC_{DC,med}$, Wh/km; $EC_{DC,high}$, Wh/km; $EC_{DC,exHigh}$,		

Step no.	*Source*	*Input*	*Process*	*Output*
6	Output step 1	E_{AC}, Wh;	Calculation of electric energy consumption at the mains according to paragraph 4.3.4. of this annex. Output is available for each test.	EC_{WLTC}, Wh/km; EC_{city}, Wh/km; EC_{low}, Wh/km; EC_{med}, Wh/km; EC_{high}, Wh/km; EC_{exHigh}, Wh/km.
	Output step 5	PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km.		
7 If the interpolation method is not applied, step No. 10 is not required and the output of this step for $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ is the final result.	Output step 5	PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km;	Averaging of tests for all input values. Declaration of $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ based on $PER_{WLTC,ave}$ and $EC_{WLTC,ave}$. Alignment of PER in case of city, low, med, high and exHigh based on the ratio between $PER_{WLTC,dec}$ and $PER_{WLTC,ave}$: $$AF_{PER} = \frac{PER_{WLTC,dec}}{PER_{WLTC,ave}}$$ Alignment of EC in case of city, low, med, high and exHigh based on the ratio between $EC_{WLTC,dec}$ and $EC_{WLTC,ave}$: $$AF_{EC} = \frac{EC_{WLTC,dec}}{EC_{WLTC,ave}}$$ In the case that the interpolation method is applied, the output is available for vehicle H and vehicle L. $PER_{WLTC,dec}$ as well as $EC_{WLTC,dec}$ shall be rounded according to paragraph 6.1.8. of this Regulation to the number of places of decimal as specified in Table A6/1 of Annex B6. In the case that the interpolation method is not applied, $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number. .	$PER_{WLTC,dec}$, km; $PER_{WLTC,ave}$, km; $PER_{city,ave}$, km; $PER_{low,ave}$, km; $PER_{med,ave}$, km; $PER_{high,ave}$, km; $PER_{exHigh,ave}$, km; $EC_{WLTC,dec}$, Wh/km; $EC_{WLTC,ave}$, Wh/km; $EC_{city,ave}$, Wh/km; $EC_{low,ave}$, Wh/km; $EC_{med,ave}$, Wh/km; $EC_{high,ave}$, Wh/km; $EC_{exHigh,ave}$, Wh/km; $EC_{DC,first,ave}$, Wh/km.
	Output step 6	EC_{WLTC}, Wh/km; EC_{city}, Wh/km; EC_{low}, Wh/km; EC_{med}, Wh/km; EC_{high}, Wh/km; EC_{exHigh}, Wh/km.		
	Output step 4	$EC_{DC,first}$, Wh/km.		

Step no.	*Source*	*Input*	*Process*	*Output*
8	Output step 7	$EC_{WLTC,dec}$, Wh/km; $EC_{WLTC,ave}$, Wh/km; $EC_{DC,first,ave}$, Wh/km.	Adjustment of the electric energy consumption for the purpose of COP as described in paragraph 1.2. of Appendix 8 to this annex. In the case that the interpolation method is applied, the output is available for vehicle H and vehicle L.	$EC_{DC,COP}$, Wh/km.
9 If the interpolation method is not applied, step No. 10 is not required and the output of this step is the final result.	Output step 7	$PER_{city,ave}$, km; $PER_{low,ave}$, km; $PER_{med,ave}$, km; $PER_{high,ave}$, km; $PER_{exHigh,ave}$, km; $EC_{city,ave}$, Wh/km; $EC_{low,ave}$, Wh/km; $EC_{med,ave}$, Wh/km; $EC_{high,ave}$, Wh/km; $EC_{exHigh,ave}$, Wh/km;	Intermediate rounding according to paragraph 6.1.8. of this Regulation. In the case that the interpolation method is applied, intermediate rounding shall be performed according to paragraph 6.1.8. of this Regulation: PER_{city} and PER_p shall be rounded to the first place of decimal. EC_{city} and EC_p shall be rounded to the first place of decimal. $EC_{DC,COP}$ shall be rounded to the first place of decimal. The output is available for vehicle H and vehicle L. In case that the interpolation method is not applied, final rounding of the test results according to paragraph 6.1.8. of this Regulation: PER_{city} and PER_p shall be rounded to the nearest whole number. EC_{city} and EC_p shall be rounded to the nearest whole number. $EC_{DC,COP}$ shall be rounded to the nearest whole number.	$PER_{city,final}$, km; $PER_{low,final}$, km; $PER_{med,final}$, km; $PER_{high,final}$, km; $PER_{exHigh,final}$, km; $EC_{city,final}$, Wh/km; $EC_{low,final}$, Wh/km; $EC_{med,final}$, Wh/km; $EC_{high,final}$, Wh/km; $EC_{exHigh,final}$, Wh/km; $EC_{DC,COP,final}$, Wh/km.
	Output step 8	$EC_{DC,COP}$, Wh/km.		
10	Output step 7	$PER_{WLTC,dec}$, km; $EC_{WLTC,dec}$, Wh/km	Interpolation of individual values based on input from vehicle H and vehicle L according to paragraph	$PER_{WLTC,ind}$, km; $PER_{city,ind}$, km; $PER_{low,ind}$, km;

Step no.	*Source*	*Input*	*Process*	*Output*
Result of an individual vehicle. Final test result.	Output step 9	$PER_{city,final}$, km; $PER_{low,final}$, km; $PER_{med,final}$, km; $PER_{high,final}$, km; $PER_{exHigh,final}$, km; $EC_{city,final}$, Wh/km; $EC_{low,final}$, Wh/km; $EC_{med,final}$, Wh/km; $EC_{high,final}$, Wh/km; $EC_{exHigh,final}$, Wh/km; $EC_{DC,COP,final}$, Wh/km.	4.5. of this annex, and final rounding according to paragraph 6.1.8. of this Regulation. PER_{ind}, $PER_{city,ind}$, and $PER_{p,ind}$ shall be rounded to the nearest whole number. $EC_{ind,}$ ECc_{ity} and $EC_{p,ind}$ shall be rounded to the nearest whole number. $EC_{DC,COP,ind}$ shall be rounded to the nearest whole number. The output is available for each individual vehicle.	$PER_{med,ind}$, km; $PER_{high,ind}$, km; $PER_{exHigh,ind}$, km; $EC_{WLTC,ind}$, Wh/km; $EC_{city,ind}$, Wh/km; $EC_{low,ind}$, Wh/km; $EC_{med,ind}$, Wh/km; $EC_{high,ind}$, Wh/km; $EC_{exHigh,ind}$, Wh/km; $EC_{DC,COP,ind}$, Wh/km.

4.7.2. Stepwise procedure for calculating the final test results of PEVs in case of the shortened test procedure

For the purpose of this table, the following nomenclature within the questions and results is used:

j index for the considered period.

Table A8/11

Calculation of final PEV values determined by application the shortened Type 1 test procedure

Table A8/11 shall be performed separately for results after 4 phases and for results after 3 phases.

For results after 4 phases;

The considered periods shall be the low phase, medium phase, high phase, extra high phase, the applicable WLTP city test cycle and the applicable WLTP test cycle.

For results after 3 phases;

The considered periods shall be the low phase, medium phase, high phase and the applicable WLTP test cycle.

Step no.	*Source*	*Input*	*Process*	*Output*
1	Annex B8	Test results	Results measured according to Appendix 3 to this annex, and pre-calculated according to paragraph 4.3. of this annex. Usable battery energy according to paragraph 4.4.2.1.1. of this annex. Recharged electric energy according to paragraph 3.4.4.3. of this annex. Output is available for each test. E_{AC} shall be rounded according to paragraph 6.1.8. of this Regulation to the first place of decimal.	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{STP}, Wh; E_{AC}, Wh.
2	Output step 1	$\Delta E_{REESS,j}$, Wh; UBE_{STP}, Wh.	Calculation of weighting factors according to paragraph 4.4.2.1. of this annex. Output is available for each test.	$K_{WLTC,1}$ $K_{WLTC,2}$ $K_{city,1}$ $K_{city,2}$ $K_{city,3}$ $K_{city,4}$ $K_{low,1}$ $K_{low,2}$ $K_{low,3}$ $K_{low,4}$ $K_{med,1}$ $K_{med,2}$ $K_{med,3}$ $K_{med,4}$ $K_{high,1}$ $K_{high,2}$ $K_{exHigh,1}$ $K_{exHigh,2}$

Step no.	*Source*	*Input*	*Process*	*Output*
3	Output step 1 Output step 2	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{STP}, Wh. All weighting	Calculation of electric energy consumption at the REESSs according to paragraph 4.4.2.1. of this annex. Calculation of the electric energy consumption from the first applicable WLTP test cycle $EC_{DC,first}$. Output is available for each test.	$EC_{DC,WLTC}$, Wh/km; $EC_{DC,city}$, Wh/km; $EC_{DC,low}$, Wh/km; $EC_{DC,\ med}$, Wh/km; $EC_{DC,high}$, Wh/km; $EC_{DC,exHigh}$, Wh/km; $EC_{DC,first}$, Wh/km.
4	Output step 1 Output step 3	UBE_{STP}, Wh; $EC_{DC,WLTC}$, Wh/km; $EC_{DC,city}$, Wh/km; $EC_{DC,low}$, Wh/km; $EC_{DC,\ med}$, Wh/km; $EC_{DC,high}$, Wh/km; $EC_{DC,exHigh}$, Wh/km.	Calculation of pure electric range according to paragraph 4.4.2.1. of this annex. Output is available for each test.	PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km.
5	Output step 1 Output step 4	E_{AC}, Wh; PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km.	Calculation of electric energy consumption at the mains according to paragraph 4.3.4. of this annex. Output is available for each test.	EC_{WLTC}, Wh/km; EC_{city}, Wh/km; EC_{low}, Wh/km; EC_{med}, Wh/km; EC_{high}, Wh/km; EC_{exHigh}, Wh/km.
6 If the interpolation method is not applied, step No. 9 is not required and the output of this step for $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ is	Output step 4 Output step 5	PER_{WLTC}, km; PER_{city}, km; PER_{low}, km; PER_{med}, km; PER_{high}, km; PER_{exHigh}, km; EC_{WLTC}, Wh/km; EC_{city}, Wh/km; EC_{low}, Wh/km; EC_{med}, Wh/km; EC_{high}, Wh/km; EC_{exHigh}, Wh/km.	Averaging of tests for all input values. Declaration of $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ based on $PER_{WLTC,ave}$ and $EC_{WLTC,ave}$. Alignment of PER in case of city, low, med, high and exHigh based on the ratio between $PER_{WLTC,dec}$ and $PER_{WLTC,ave}$:	$PER_{WLTC,dec}$, km; $PER_{WLTC,ave}$, km; $PER_{city,ave}$, km; $PER_{low,ave}$, km; $PER_{med,ave}$, km; $PER_{high,ave}$, km; $PER_{exHigh,ave}$, km; $EC_{WLTC,dec}$, Wh/km; $EC_{WLTC,ave}$, Wh/km; $EC_{city,ave}$, Wh/km; $EC_{low,ave}$, Wh/km;

Step no.	*Source*	*Input*	*Process*	*Output*
the final result.	Output step 3	$EC_{DC,first}$, Wh/km.	$AF_{PER} = \frac{PER_{WLTC,dec}}{PER_{WLTC,ave}}$ Alignment of EC in case of city, low, med, high and exHigh based on the ratio between $EC_{WLTC,dec}$ and $EC_{WLTC,ave}$: $AF_{EC} = \frac{EC_{WLTC,dec}}{EC_{WLTC,ave}}$ In the case that the interpolation method is applied, the output is available for vehicle H and vehicle L. $PER_{WLTC,dec}$ as well as $EC_{WLTC,dec}$ shall be rounded according to paragraph 6.1.8. of this Regulation to the number of places of decimal specified in Table A6/1 of Annex B6. In the case that the interpolation method is not applied, $PER_{WLTC,dec}$ and $EC_{WLTC,dec}$ shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number.	$EC_{med,ave}$, Wh/km; $EC_{high,ave}$, Wh/km; $EC_{exHigh,ave}$, Wh/km; $EC_{DC,first,ave}$, Wh/km.
7	Output step 6	$EC_{WLTC,dec}$, Wh/km; $EC_{WLTC,ave}$, Wh/km; $EC_{DC,first,ave}$, Wh/km.	Adjustment of the electric energy consumption for the purpose of COP as described in paragraph 1.2. of Appendix 8 to this annex. In the case that the interpolation method is applied, the output is available for vehicle H and vehicle L.	$EC_{DC,COP}$, Wh/km.
8 If the interpolation method is not applied, step No. 9 is not required and the output of this step is the final result.	Output step 6	$PER_{city,ave}$, km; $PER_{low,ave}$, km; $PER_{med,ave}$, km; $PER_{high,ave}$, km; $PER_{exHigh,ave}$, km; $EC_{city,ave}$, Wh/km; $EC_{low,ave}$, Wh/km; $EC_{med,ave}$, Wh/km; $EC_{high,ave}$, Wh/km; $EC_{exHigh,ave}$, Wh/km;	Intermediate rounding according to paragraph 6.1.8. of this Regulation. In the case that the interpolation method is applied, intermediate rounding shall be performed according to paragraph 6.1.8. of this Regulation: PER_{city} and PER_p shall be rounded to the first place of decimal. EC_{city} and EC_p shall be rounded to the first place of decimal.	$PER_{city,final}$, km; $PER_{low,final}$, km; $PER_{med,final}$, km; $PER_{high,final}$, km; $PER_{exHigh,final}$, km; $EC_{city,final}$, Wh/km; $EC_{low,final}$, Wh/km; $EC_{med,final}$, Wh/km; $EC_{high,final}$, Wh/km; $EC_{exHigh,final}$, Wh/km; $EC_{DC,COP,final}$, Wh/km.

Step no.	*Source*	*Input*	*Process*	*Output*
	Output step 7	$EC_{DC,COP}$, Wh/km.	$EC_{DC,COP}$ shall be rounded to the first place of decimal. The output is available for vehicle H and vehicle L. In case that the interpolation method is not applied, final rounding of the test results according to paragraph 6.1.8. of this Regulation shall apply: PER_{city} and PER_{p} shall be rounded to the nearest whole number. EC_{city} and EC_{p} shall be rounded to the nearest whole number. $EC_{DC,COP}$ shall be rounded to the nearest whole number.	
9 Result of an individual vehicle. Final test result.	Output step 6	$PER_{WLTC,dec}$, km; $EC_{WLTC,dec}$, Wh/km;	Interpolation of individual values based on input from vehicle H and vehicle L according to paragraph 4.5. of this annex, and final rounding according to paragraph 6.1.8. of this Regulation. PER_{ind}, $PER_{city,ind}$, and $PER_{p,ind}$ shall be rounded to the nearest whole number. $EC_{ind,}$ ECc_{ity} and $EC_{p,ind}$ shall be rounded to the nearest whole number. $EC_{DC,COP,ind}$ shall be rounded to the nearest whole number. Output is available for each individual vehicle.	$PER_{WLTC,ind}$, km; $PER_{city,ind}$, km; $PER_{low,ind}$, km; $PER_{med,ind}$, km; $PER_{high,ind}$, km; $PER_{exHigh,ind}$, km; $EC_{WLTC,ind}$, Wh/km; $EC_{city,ind}$, Wh/km; $EC_{low,ind}$, Wh/km; $EC_{med,ind}$, Wh/km; $EC_{high,ind}$, Wh/km; $EC_{exHigh,ind}$, Wh/km; $EC_{DC,COP,ind}$, Wh/km.

II. Justification

The equation for the calculation of the individual vehicle PER values was adjusted. EC and PER for individual vehicles are currently derived through linear interpolation over energy demand. Due to the linear interpolation the PER of individual vehicles are overestimated. Less simplified interpolation approach through interpolation of 1/PER to achieve more correct individual PER values.

<OVC-FCHV>

Table A6/1, Annex B6, amend to read:

Table A6/1

Applicable rules for a manufacturer's declared values (total cycle values)[(a)] (as applicable)

Powertrain		Level 1A M_{CO2} [(b)] *(g/km)*	Level 1A: *FC (kg/100 km)*	Level 1B; *FE (km/l or km/kg)*	*Electric energy consumption*[(c)] *(Wh/km)*	*All electric range / Equivalent all-electric range/ Pure Electric Range* [(c)] *(km)*
Vehicles tested according to Annex B6 (pure ICE)		M_{CO2} Paragraph 3. of Annex B7.	-	FE Paragraph 1.4. of Annex B7.	-	-
NOVC-FCHV		-	FC_{CS} Paragraph 4.2.1.2.1. of Annex B8.	FE_{CS} Paragraph 4.2.1.2.1. of Annex B8.	-	-
OVC-FCHV	CD	-	$FC_{,CD}$	N/A	**For Level 1A:** $EC_{AC,CD}$	AER
	CS	-	FC_{CS}	**FE_{CS}**	-	-
	CD/CS weighted	-	-	-	**For Level 1B EC**	EAER Paragraph 4.4.6.1. of Annex B8
NOVC-HEV		$M_{CO2,CS}$ Paragraph 4.1.1. of Annex B8.	-	FE_{CS} Paragraph 4.1.1.1. of Annex B8.	-	-
OVC-HEV	CD	$M_{CO2,CD}$ Paragraph 4.1.2. of Annex B8.	-	FE_{CD} Paragraph 4.6.1. of Annex B8.	For Level 1A: $EC_{AC,CD}$ Paragraph 4.3.1. of Annex B8.	**For Level 1A:** AER Paragraph 4.4.1.1. of Annex B8.
	CS	$M_{CO2,CS}$ Paragraph 4.1.1. of Annex B8.	-	FE_{CS} Paragraph 4.1.1.1. of Annex B8.	-	-
	CD/CS weighted	-	-	-	For Level 1B: EC Paragraph 4.6.2. of Annex B8	EAER Paragraph 4.4.4.1. of Annex B8
PEV		-	-	-	EC_{WLTC} Paragraph 4.3.4.2. of Annex B8.	PER_{WLTC} Paragraph 4.4.2. of Annex B8.

[(a)] The declared value shall be the value to which the necessary corrections, as applicable, are applied

[(b)] Rounding to 2 places of decimal according to paragraph 6.1.8. of this Regulation

[(c)] Rounding to one place of decimal according to paragraph 6.1.8. of this Regulation

Table A8/7, Annex B8, amend to read:

Table A8/7

Calculation of final charge-sustaining fuel consumption for NOVC-FCHVs and OVC-FCHVs and fuel efficiency for NOVC-FCHV **and OVC-FCHVs** (FE applicable for Level 1B only)

Level 1A – all the calculations in this table shall be for the complete cycle only

Level 1B - all the calculations in this table shall be for the complete cycle and also for individual phases **for NOVC-FCHVs;**

all the calculations in this table shall be for the complete cycle only for OVC-FCHVs;

Paragraph 4.1, Annex B8, add new sub-paragraph:

4.1.4 This paragraph is applicable for Level 1B only:

Charge-depleting H_2 emission for OVC-HEVs

The charge-depleting H2 emission MH2,CD shall be calculated using the following equation:

$$\mathbf{M_{H2,CD}} = \frac{\sum_{j=1}^{k}(\mathbf{M_{H2,CD,j}} \times \mathbf{d_j})}{\sum_{j=1}^{k} \mathbf{d_j}}$$

where:

$\mathbf{M_{H2,CD}}$ **is the charge-depleting H_2 emission, g/km;**

$\mathbf{M_{H2,CD,j}}$ **is the H_2 emission determined according to paragraph 3.2.1. of Annex B7 of phase j of the charge-depleting Type 1 test, g/km;**

j is the index number of the considered phase;

k is the number of phases driven up to the end of the transition cycle according to paragraph 3.2.4.4. of this annex.

Paragraph 4.4.3, Annex B8, amend to read:

4.4.3. Charge-depleting cycle range for OVC-HEVs **and OVC-FCHVs**

The charge-depleting cycle range R_{CDC} shall be determined from the charge-depleting Type 1 test described in paragraph 3.2.4.3. of this annex as part of the Option 1 test sequence and referenced in paragraph 3.2.6.1. of this annex as part of the Option 3 test sequence. The R_{CDC} is the distance driven from the beginning of the charge-depleting Type 1 test to the end of the transition cycle according to paragraph 3.2.4.4. of this annex.

Paragraph 4.4.6, Annex B8, amend to read:

4.4.6. ~~**This paragraph is applicable only for Level 1A;**~~

Equivalent all-electric range for OVC-FCHVs

Paragraph 4.4.6.1, Annex B8, amend to read:

4.4.6.1. Determination of cycle-specific equivalent all-electric range

The cycle-specific equivalent all-electric range shall be calculated using the following equation:

For Level 1A;

$$\mathrm{EAER} = \left(\frac{FC_{\mathrm{CS,ave}} - \mathrm{FC_{CD,avg,ave}}}{\mathrm{FC_{CS,ave}}}\right) \times \mathrm{R_{CDC,ave}}$$

For Level 1B;

$$\mathbf{EAER} = \left(\frac{\mathbf{1/FE_{CS,declared}} - \mathbf{M_{H2,CD,avg}}}{\mathbf{1/FE_{CS,declared}}}\right) \times \mathbf{R_{CDC}}$$

where:

EAER is the cycle-specific equivalent all-electric range, km;

$\mathrm{FC_{CS,ave}}$ is the charge-sustaining fuel consumption according to Table A8/7 Step 4, kg/100km;

$FC_{\mathrm{CD,avg,ave}}$ is the arithmetic average of the charge-depleting fuel consumption $FC_{\mathrm{CD,avg}}$ calculated for all individual charge-depleting tests according to the equation below, kg/100km;

$\mathbf{FE_{CS,declared}}$ **is the charge-sustaining fuel efficiency declaration according to Table A8/7 Step5, km/kg;**

$\mathrm{R_{CDC,ave}}$ is the arithmetic average of charge-depleting cycle range ($\mathrm{R_{CDC}}$) calculated for all individual charge-depleting tests according to paragraph 4.4.3. of this annex, km;

$\mathbf{R_{CDC}}$ **is the charge-depleting cycle range($\mathbf{R_{CDC}}$) according to paragraph 4.4.3 of this annex, km;**

and

$$FC_{\mathrm{CD,avg}} = \frac{\sum_{j=1}^{k}(\mathrm{FC_{CD,j}} \times \mathrm{d_j})}{\sum_{j=1}^{k} \mathrm{d_j}}$$

where:

$FC_{CD,avg}$ is the charge-depleting fuel consumption, kg/100 km;

$FC_{CD,j}$ is the fuel consumption of phase j of the charge-depleting Type 1 test, kg/100km;

d_j is the distance driven in phase j of the charge-depleting Type 1 test, km;

j is the index number of the considered phase;

k is the number of phases driven up to the end of the transition cycle n according to paragraph 3.2.4.4. of this annex.]

$$\mathbf{M_{H2,CD,avg}} = \frac{\sum_{j=1}^{k}(\mathbf{M_{H2,CD,j}} \times \mathbf{d_j})}{\sum_{j=1}^{k} \mathbf{d_j}}$$

where:

$M_{H2,CD,avg}$ is the charge-depleting H_2 emission, g/km;

$M_{H2,CD,j}$ is the H_2 emission determined according to paragraph 3.2.1. of Annex B7 of phase j of the charge-depleting Type 1 test, g/km;

d_j is the distance driven in phase j of the charge-depleting Type 1 test, km;

j is the index number of the considered phase;

k is the number of phases driven up to the end of the transition cycle n according to paragraph 3.2.4.4. of this annex.]

The considered phase j shall be the applicable WLTP test cycle only.

Table A8/9a, Annex B8, amend to read:

Table A8/9a

Calculation of final charge-depleting values for OVC-FCHVs

~~**For Level 1A –**~~ All the calculations in this table shall be for the complete cycle only

Step no.	*Source*	*Input*	*Process*	*Output*
1	Annex B8	Charge-depleting test results	Results measured according to Appendix 3 to this annex, pre-calculated according to paragraph 4.3. of this annex. Usable battery energy according to paragraph 4.4.1.2.2. of this annex. Recharged electric energy according to paragraph 3.2.4.6. of this annex. Cycle energy according to paragraph 5. of Annex B7. Fuel consumption **and H_2 emission** according to paragraph 6. of Annex B7. All-electric range determined according to paragraph 4.4.1.1. of this annex. In the case that the applicable WLTC city test cycle was driven: all- electric range city according to paragraph 4.4.1.2.1. of this annex. H_2 fuel consumption $K_{fuel,FCHV}$ correction coefficient might be necessary according to Appendix 2 to this annex. Output is available for each test.	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{city}, Wh; E_{AC}, Wh; E_{cycle}, Ws; $FC_{CD,j}$, kg/100 km; **$M_{H2,CD,j}$, kg/km;** AER, km; AER_{city}, km. $K_{fuel,FCHV}$, (kg/100km)/(Wh/100km).
2	Output step 1	$\Delta E_{REESS,j}$, Wh; E_{cycle}, Ws.	Calculation of relative electric energy change for each cycle according to paragraph 3.2.4.5.2. of this annex. Output is available for each test and each applicable WLTP test cycle.	$REEC_i$.

Step no.	*Source*	*Input*	*Process*	*Output*
3	Output step 2	$REEC_i$.	Determination of the transition and confirmation cycle according to paragraph 3.2.4.4. of this annex. In the case that more than one charge-depleting test is available for one vehicle, for the purpose of averaging, each test shall have the same transition cycle number n_{veh}. Determination of the charge-depleting cycle range according to paragraph 4.4.3. of this annex. Output is available for each test.	n_{veh}; R_{CDC}; km.
4	Output step 3	n_{veh};	In the case that the interpolation method is used, the transition cycle shall be determined for vehicle H, L and, if applicable, M. Check whether the interpolation criterion according to paragraph 6.3.2.2. of this Regulation is fulfilled.	$n_{veh,L}$; $n_{veh,H}$; if applicable $n_{veh,M.}$
For Level 1A, 5	Output step 1	$\Delta E_{REESS,j}$, Wh; d_j, km; UBE_{city}, Wh.	In the case that AER_{city} is derived from the Type 1 test by driving the applicable WLTP test cycles, the value shall be calculated according to paragraph 4.4.1.2.2. of this annex. In the case of more than one test, $n_{city,pe}$ shall be equal for each test. Output is available for each test. Averaging of AER_{city}.	AER_{city}, km; $AER_{city,ave}$, km.
For Level 1A, 6	Output step 1 Output step 3 Output step 4	d_j, km; n_{veh}; $n_{veh,L}$;	Phase-specific and cycle-specific UF calculation. Output is available for each test.	$UF_{phase,j}$; $UF_{cycle,c}$.
For Level 1A, 7	Output step 1 Output step 3 Output step 4	$\Delta E_{REESS,j}$, Wh; d_j, km; E_{AC}, Wh; n_{veh}; $n_{veh,L}$;	Calculation of the electric energy consumption based on the recharged energy according. to paragraphs 4.3.1. and 4.3.2. of this annex. In the case of interpolation, $n_{veh,L}$ cycles shall be used. Therefore, due	$EC_{AC,weighted}$, Wh/km; $EC_{AC,CD}$, Wh/km;

Step no.	*Source*	*Input*	*Process*	*Output*
	Output step 6	$UF_{phase,j}$;	to the required correction of the fuel consumption, the electric energy consumption of the confirmation cycle and its phases shall be set to zero. Output is available for each test.	
8	Output step 1 Output step 3 Output step 4 Output step 6	$FC_{CD,j}$, l/100 km **$M_{H2,CD,j}$, kg/km** $K_{fuel,FCHV}$, (kg/100km)/(Wh/100 km); $\Delta E_{REESS,j}$, Wh; d_j, km; n_{veh}; $n_{veh,L}$; $UF_{phase,j}$.	Calculation of the charge-depleting fuel consumption according to paragraph 4.2.2. of this annex. **Calculation of the charge-depleting H_2 emission according to paragraph 4.1.4. of this annex.** In the case that the interpolation method is applied, $n_{veh,L}$ cycles shall be used. With reference to paragraph 4.1.2. of this annex, the confirmation cycle shall be corrected according to Appendix 2 to this annex. Output is available for each test.	**For Level 1A,** FC_{CD}, kg/100km; **For Level 1B,** **$M_{H2,CD}$, kg/km;**
(Reserved)				
10	Output step 7 Output step 8	$EC_{AC,weighted}$, Wh/km; $EC_{AC,CD}$, Wh/km; FC_{CD}, kg/100 km. **$M_{H2,CD}$, kg/km;**	Averaging of tests for each vehicle. In the case that the interpolation method is applied, the output is available for each vehicle H, L and, if applicable, M.	**For Level 1A,** $EC_{AC,weighted,ave}$, Wh/km; $EC_{AC,CD,ave}$, Wh/km; $FC_{CD,ave}$, kg/100 km. **For Level 1B,** **$M_{H2,CD,avg}$, kg/km;**
For Level 1A, 11	Output step 10	$EC_{AC,CD,ave}$, Wh/km; $FC_{CD,ave}$, kg/100 km;	Declaration of charge-depleting electric energy consumption and fuel consumption for each vehicle. In the case that the interpolation method is applied, the output is available for each vehicle H, L and, if applicable, M.	$EC_{AC,CD,declared}$, Wh/km; $FC_{CD,declared}$, kg/100 km;
(Reserved)				
For Level 1A, 13	Output step 11	$EC_{AC,CD,declared}$, Wh/km;	In the case that the interpolation method is applied, intermediate rounding shall be performed	$EC_{AC,CD,final}$, Wh/km; $EC_{AC,weighted,final}$, Wh/km;

Step no.	*Source*	*Input*	*Process*	*Output*
If the interpolation method is not applied, step No. 14 is not required and the output of this step is the final result.	Output step 10	$EC_{AC,weighted,ave}$, Wh/km; $FC_{CD,ave}$, kg/100 km;	according to paragraph 6.1.8. of this Regulation. FC_{CD} shall be rounded to the third place of decimal. $EC_{AC,CD}$ and $EC_{AC,weighted}$ shall be rounded to the first place of decimal. Output is available for vehicle H and for vehicle L and, if applicable, for vehicle M. In case that the interpolation method is not applied, final rounding shall be applied according to paragraph 6.1.8. of this Regulation. $EC_{AC,CD}$ and $EC_{AC,weighted}$ shall be rounded to the nearest whole number. FC_{CD} shall be rounded to the second place of decimal.	$FC_{CD,final}$, l/100 km;
For Level 1A, 14 Result of an individual vehicle. Final test result.	Output step 13	$EC_{AC,CD,final}$, Wh/km; $EC_{AC,weighted,final}$, Wh/km; $FC_{CD,final}$, kg/100 km;	Interpolation of individual values based on input from vehicles H and L and, if applicable, vehicle M. Final rounding of individual vehicle values shall be performed according to paragraph 6.1.8. of this Regulation. $EC_{AC,CD}$, $EC_{AC,weighted}$ shall be rounded to the nearest whole number. FC_{CD} shall be rounded to the second place of decimal. Output is available for each individual vehicle.	$EC_{AC,CD,ind}$, Wh/km; $EC_{AC,weighted,ind}$, Wh/km; $FC_{CD,ind}$, kg/100 km;

Table A8/9b, Annex B8, amend to read:

Table A8/9b

Calculation of final charge-depleting and charge-sustaining weighted values for OVC-FCHVs

(FE is applicable for Level 1B only:)

~~**For Level 1A –**~~ All the calculations in this table shall be for the complete cycle only

Step no.	*Source*	*Input*	*Process*	*Output*
1	Output step 1, Table A8/9a	$FC_{CD,j}$, kg/100 km $\Delta E_{REESS,j}$, Wh; d_j, km; AER, km; E_{AC}, Wh; **$M_{H2,CD,j}$ kg/km;**	Input from CD and CS postprocessing. The arithmetic average of E_{AC} for all individual charge-depleting tests shall be calculated. Output in the case of CD is available for each CD test. Output in the case of CS is available once due to CS test averaged values. In the case that the interpolation method is applied, the output (except of $K_{fuel,FCHV}$) is available for vehicle H, L and, if applicable, M.	$FC_{CD,j}$, kg/100 km; $\Delta E_{REESS,j}$, Wh; d_j, km; AER, km; E_{AC}, Wh; **$M_{H2,CD}$, kg/km;** $AER_{city,ave}$, km; n_{veh}; R_{CDC}, km; $n_{veh,L}$; $n_{veh,H}$; $UF_{phase,j}$; $UF_{cycle,c}$; $FC_{CS,declared}$, kg/100km; $FC_{CS,p}$, kg/100km; **$FE_{CS,declared}$, kg/100km;** $FC_{CD,declared}$, kg/100km; $FC_{CD,ave}$, kg/100km; **$M_{H2,CD,avg}$ kg/km;**
	Output step 5, Table A8/9a	$AER_{city,ave}$, km;		
	Output step 3, Table A8/9a	n_{veh}; R_{CDC}, km;		
	Output step 4, Table A8/9a	$n_{veh,L}$; $n_{veh,H}$;		
	Output step 6, Table A8/9a	**For Level 1A,** $UF_{phase,j}$; $UF_{cycle,c}$;		
	Output step 5 Table A8/7	$FC_{CS,declared}$, kg/100km; $FC_{CS,p}$, kg/100km; **$FE_{CS,declared}$, kg/100km;**		
	Output step 11, Table A8/9a	$FC_{CD,declared}$, kg/100km;		
	Output step 10, Table A8/9a	$FC_{CD,ave}$, kg/100km; **$M_{H2,CD,avg}$ kg/km;**		
		$K_{fuel,FCHV}$, (kg/100km)/(Wh/100km).	H_2 correction coefficient $K_{fuel,FCHV}$ might be necessary according to Appendix 2 to this annex.	$K_{fuel,FCHV}$, (kg/100km)/(Wh/100 km).

Step no.	*Source*	*Input*	*Process*	*Output*
2	Output step 1,	$FC_{CD,j}$, kg/100 km; $\Delta E_{REESS,j}$, Wh; d_j, km; **$M_{H2,CD}$, kg/km;** n_{veh}; R_{CDC}, km ; $FC_{CS,p}$, kg/100km **$FE_{CS,declared}$, kg/100km;** **$M_{H2,CD,avg}$ kg/km;**	Calculation of equivalent all-electric range according to paragraphs 4.4.6.1. and4.4.6.2. of this annex **For Level 1B;** **Output is available for each CD test.** ~~**and**~~**Calculation of** actual charge-depleting range according to paragraph 4.4.~~**5**~~**7**. of this annex. R_{CDA} is available for each CD test. The arithmetic average of R_{CDA} for all individual charge-depleting tests shall be calculated and shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number.	EAER, km; ~~**$EAER_{p,2}$, km;**~~ R_{CDA}, km.
3	Output step 1	AER, km;	Output is available for each CD test. In the case that the interpolation method is applied, check the availability of AER interpolation between vehicle H, L and, if applicable, M according to paragraph 4.5.7.1. of this annex. If the interpolation method is used, each test shall fulfil the requirement.	AER-interpolation availability.
	Output step 2	R_{CDA}, km.		

Step no.	*Source*	*Input*	*Process*	*Output*
4 If the interpolation method is not applied, step No. 8 is not required and the output of this step is the final result.	Output step 1 Output step 2	AER, km. EAER, km; ~~$EAER_{p,2}$, km;~~	Averaging AER and AER declaration. **Average** EAER**(for Level 1B only) and EAER** declaration ~~and~~ ~~$EAER_{p,4} - EAER_{p,2} \times \frac{EAER_{dec}}{EAER}$~~ The declared AER**(for Level 1A only)** and EAER shall be rounded according to paragraph 6.1.8. of this Regulation to the number of decimal places specified in Table A6/1 of Annex B6. In the case that the interpolation method is applied and the AER interpolation availability criterion is fulfilled, AER shall be rounded according to paragraph 6.1.8. of this Regulation to the first place of decimal. In the case that the interpolation method is applied, EAER ~~and $EAER_p$~~ shall be rounded according to paragraph 6.1.8. of this Regulation to the first place of decimal. The output is available for each vehicles H and L and, if applicable, for vehicle M. If the case that the interpolation method is applied but the criterion is not fulfilled, AER of vehicle H shall be applied for the whole interpolation family and shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number. In the case that the interpolation method is not applied, AER **and** EAER ~~and $EAER_p$~~ shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number.	AER_{ave}, km; ~~AER_{dec}, km.~~ $EAER_{dec}$, km; ~~$EAER_{p,4}$, km;~~ **For Level 1A only** **AER_{dec}, km.**

Step no.	*Source*	*Input*	*Process*	*Output*
For Level 1A; 5	Output step 1	$FC_{CD,j}$, kg/100 km n_{veh}; $n_{veh,L}$; $UF_{phase,j}$; $FC_{CS,declared}$, kg/100km; $FC_{CD,declared}$, kg/100km; $FC_{CD,ave}$, kg/100km;	Calculation of weighted fuel consumption according to paragraph 4.2.3. of this annex. Output is available for each CD test. In the case that the interpolation method is applied, $n_{veh,L}$ cycles shall be used. With reference to paragraph 4.2.2. of this annex, $FC_{CD,j}$ of the confirmation cycle shall be corrected according to Appendix 2 to this annex.	$FC_{weighted}$, kg/100 km;
6	Output step 1 Output step 2	E_{AC}, Wh; EAER, km; ~~**$EAER_{p,2}$, km;**~~	Calculation of the electric energy consumption based on EAER according to paragraphs 4.3.3.1. and 4.3.3.2. of this annex. **For Level 1B;** **Output is available for each CD test.**	EC, Wh/km; ~~**EC_p, Wh/km;**~~
7 If the interpolation method is not applied, step No. 8 is not required and the	Output step 1	$AER_{city, ave}$, km;	**For Level 1B;** **Averaging EC and EC declaration.** **For Level 1A;** Averaging of all values except EAER and EC and intermediate rounding of all values according to paragraph 6.1.8. of this Regulation.	**For Level 1B;** **EC_{dec}, Wh/km;** **$EAER_{final}$, km;** **For Level 1A;** $AER_{city,final}$, km; $FC_{weighted,final}$, kg/100 km; EC_{final}, Wh/km;
	Output step 5	$FC_{weighted}$, kg/100 km;		
	Output step 6 Output step 4	EC, Wh/km; ~~**EC_p, Wh/km;**~~ EAER, km; ~~**$EAER_p$, km;**~~		

Step no.	*Source*	*Input*	*Process*	*Output*
output of this step is the 'Final result'.	Output step 5	AER_{dec}, km; AER_{ave}, km.	In the case that the interpolation method is applied, intermediate rounding shall be performed according to paragraph 6.1.8. of this Regulation. $AER_{city,final} = AER_{city,ave} \times \frac{AER_{dec}}{AER_{ave}}$ $AER_{city,final}$**;** **and** EAER **and** ~~**$EAER_p$**~~ shall be rounded to the first place of decimal. $FC_{weighted}$ shall be rounded to the third place of decimal. EC ~~**and EC_p**~~ shall be rounded to the first place of decimal. The output is available for each vehicle H, vehicle L and, if applicable, vehicle M. In case that the interpolation method is not applied, final rounding of the test results shall be applied according to paragraph 6.1.8. of this Regulation. $AER_{city,ave}$, EAER and $EAER_p$ shall be rounded to the nearest whole number. $FC_{weighted}$ shall be rounded to the second place of decimal. EC ~~**and EC_p**~~ shall be rounded to the nearest whole number.	~~**$EC_{p,final}$; Wh/km;**~~ $EAER_{final}$, km; ~~**$EAER_{p,final}$; km;**~~
8	Output step 5 Output step 7	AER_{dec}, km; $AER_{city,final}$, km; $FC_{weighted,final}$, kg/100 km; EC_{final}, Wh/km; ~~**$EC_{p,final}$; Wh/km;**~~ $EAER_{final}$, km; ~~**$EAER_{p,final}$; km;**~~	Interpolation of individual values based on input from vehicle low, medium and high according to paragraph 4.5. of this annex, and final rounding according to paragraph 6.1.8. of this Regulation. AER_{ind},$AER_{city,ind}$**;** **and** $EAER_{ind}$ ~~**and $EAER_{p,ind}$**~~ shall be rounded to the nearest whole number. $EC_{weighted,ind}$ shall be rounded to the first place of decimal.	AER_{ind}, km; ~~**$AER_{city,ind}$; km;**~~ ~~**$FC_{weighted,ind}$; kg/100 km;**~~ EC_{ind}, Wh/km; ~~**$EC_{p,ind}$ Wh/km;**~~ $EAER_{ind}$, km; ~~**$EAER_{p,ind}$; km**~~ **For Level 1A;** **$AER_{city,ind}$, km;** **$FC_{weighted,ind}$, kg/100 km;**
	Output step 4	AER-interpolation availability.		

Step no.	*Source*	*Input*	*Process*	*Output*
	Output step 1	R_{CDC}	$FC_{weighted,ind}$ shall be rounded to the second place of decimal. EC_{ind} ~~**and $EC_{p,ind}$**~~ shall be rounded to the nearest whole number. Output is available for each individual vehicles. R_{CDC} shall be rounded according to paragraph 6.1.8. of this Regulation to the nearest whole number.	$R_{CDC,final}$

II. Justification

2. OVC-FCHV has been launched to the Japanese market, and Type1 test of OVC-FCHV is required for Level 1B. Therefore, Japan add Type 1 test procedure for OVC-FCHV aligned with OVC-HEV for Level 1B.

3. On the other hand, Japan understands that the frequent amendments of this Regulation is not efficient from the viewpoint of UNECE amendment process and homologation process in each region. Therefore, Japan follows GRPE decision if this amendment would be voted at WP.29 as a consolidated document including the other amendments yet to come in the near future.

<FCHV Interpolation method >

Table A8/7 **Annex B8, amend to read:**

Calculation of final charge-sustaining fuel consumption for NOVC-FCHVs and OVC-FCHVs and fuel efficiency for NOVC-FCHV (FE applicable for Level 1B only)

Commented [JAMA13]: FCHV 試験法詳細の追記

Step No.	*Source*	*Input*	*Process*	*Output*
5 If the interpolation method is not applied, step No. 6 is not required and the output of this step is the final result. ~~FC_{CS}~~ **R**esults of a Type 1 test for a test vehicle.	Output step 4	$FC_{CS,p,4}$, kg/100 km; $FC_{CS,c,4}$, kg/100 km; $FC_{CS,c,declared}$, kg/100 km. $FE_{CS,p,4}$, km/kg. $FE_{CS,c,4}$, km/kg; $FE_{CS,c,declared}$, km/ kg.	Alignment of phase values. Paragraph 1.2.4. of Annex B6, **For level-1B, alignment of phase values.** $FE_{cs,p,5} = FE_{CS,p,4} \times \frac{FE_{CS,c\,declared}}{(FC_{phase\ combined\ value}/100)}$ **Phase combined value of FC shall be derived from the formula in paragraph 1.2.4. of Annex B6. CO2 shall be replaced by FC.** and: $FC_{CS,c,5} = FC_{CS,c,declared}$ $FE_{CS,c,5} = FE_{CS,c,declared}$ FC **values** and FE values shall be rounded according to paragraph 6.1.8. of this Regulation. FC **values** shall be rounded to the third place of decimal. FE **values** shall be rounded to ~~**the nearest whole number**~~ **the first place of decimal.** In the case that the interpolation method is not applied, final rounding ~~**of FC**~~ shall be applied according to paragraph 6.1.8. of this Regulation. **FC values shall be rounded** to the second place of decimal. **FE values shall be rounded to the nearest whole number.**	$FC_{CS,p,5}$, kg/100 km; $FC_{CS,c,5}$, kg/100 km $FE_{CS,p,5}$, km/kg. $FE_{CS,c,5}$, km/kg.
6 Result of an individual vehicle. Final ~~**FC**~~ result.	Output step 5	$FC_{CS,c,5}$, kg/100 km; **$FE_{CS,c,5}$, km/kg** **$FE_{CS,p,5}$, km/kg**	Fuel consumption calculation according to paragraph 4.5.5.1.3. of this annex for individual vehicles in an interpolation family. **Fuel efficiency calculation according to paragraph 4.5.5.1.4. of this annex for**	$FC_{CS,c,ind}$, kg/100 km; **$FE_{CS,c,ind}$, , km/kg** **$FE_{CS,p,ind}$, , km/kg**

			individual vehicles in an interpolation family. Final rounding of individual vehicle values shall be performed according to paragraph 6.1.8. of this Regulation. FC values shall be rounded to the second place of decimal. **FE values shall be rounded to the nearest whole number.** Output is available for each individual vehicle.		

Paragraph 4.5.5.1.4. **Annex B8, amend *(add)* to read:**

4.5.5.1.4. This paragraph is only applicable for Level 1B:
Individual charge-sustaining fuel consumption for NOVC-FCHVs.

The charge-sustaining fuel efficiency for an individual vehicle shall be calculated using the following equation:

$$FE_{ind,CS,p} = 1/[\ 1/FE_{L,CS,p} + K_{ind,p} \times (1/FE_{H,CS,p} - 1/FE_{L,CS,p})]$$

where:

$FE_{ind,CS,p}$ **is the charge-sustaining fuel efficiency for an individual vehicle of the considered period p according to Table A8/7, step No. 6, km/kg;**

$FE_{L,CS,p}$ **is the charge-sustaining fuel efficiency for vehicle L of the considered period p according to Table A8/7, step No. 5, km/kg;**

$FE_{H,CS,p}$ **is the charge-sustaining fuel efficiency for vehicle H of the considered period p according to Table A8/7, step No. 5, km/kg;**

$K_{ind,p}$ **is the interpolation coefficient for the considered individual vehicle for period p;**

p is the index of the individual period within the applicable WLTP test cycle.

The considered periods shall be the low phase, medium phase, high phase and the applicable WLTP test cycle.

Paragraph 2.1. Annex B8 - Appendix 2, amend *(add)* to read:

2. Calculation of correction coefficients

2.1. The CO_2 emission correction coefficient K_{CO2}, the fuel consumption correction coefficients $K_{fuel,FCHV}$, as well as, if required by the manufacturer, the phase-specific correction coefficients $K_{CO2,p}$ and $K_{fuel,FCHV,p}$ shall be developed based on the applicable charge-sustaining Type 1 test cycles.

In the case that vehicle H was tested for the development of the correction coefficient for CO_2 emission for NOVC-HEVs and OVC-HEVs, the coefficient may be applied to vehicles that fulfil the same interpolation family criteria. For interpolation families which fulfil the criteria of the K_{CO2} correction factor family, defined in paragraph 6.3.11. of this Regulation, the same K_{CO2} value may be applied.

In the case that vehicle H was tested for the development of the correction coefficient for fuel consumption for NOVC-FCHVs and OVC-FCHVs, the coefficient may be applied to vehicles that fulfil the same interpolation family criteria.

II. Justification

Addition of missing descriptions necessary for NOVC-FCHV operation, basically equivalent to PEV.

<Range Test for OVC-FCHV and NOVC-FCHV>

*Paragraph 2, add ne*w abbreviation:

2. Abbreviations

2.1. General abbreviations

P_{LL}	**Lower limit pressure**

Paragraph 6.3, add new sub-paragraph:

6.3.12. Lower limit pressure family for NOVC-FCHVs

Only NOVC-FCHVs that are identical with respect to the following specifications may be part of the same family of :

(a) Operation strategy of all components determining the lower limit pressure of on-board hydrogen tank (pressure value set to initiate shutdown of fuel supply system etc.).

(b) If no specific operation strategy determining the lower limit pressure of on-board hydrogen tank, all items of interpolation family listed in paragraph 6.3.2.4.

Paragraph 3.5.7.6.4., Annex A1, add new sub-paragraph:

3.5.7.6.4. Fuel efficiency and driving range for NOVC-FCHV
3.5.7.6.4.1. Vehicle high: ... km/kg
3.5.7.6.4.2. Vehicle low (if applicable): ... km/kg
3.5.7.6.4.3. Vehicle M (if applicable): ... km/kg
3.5.7.6.4.4. Driving range (if applicable):…. km

Paragraph 2.1.1.4., Annex A1 – Appendix 1, add new sub-paragraph:

2.1.1.4.3. Ranges for NOVC-FCHVs - driving range (if applicable)

Test 1

P_{LL}, Lower limit pressure (MPa)	**–**
Measured value P_{LL}	
Declared value P_{LL}	

Test 2 (if applicable)
Record test results in accordance with the table of Test 1

Test 3 (if applicable)
Record test results in accordance with the table of Test 1

Conclusion

P_{LL} (MPa)	**–**
Final value P_{LL}	

Driving range (km)	**Combined**
Calculated value	

Paragraph 2.5.4., Annex A2, amend to read:

2.5.4. Not Off Vehicle Charging Fuel Cell Hybrid Vehicles (NOVC-FCHV)

Fuel Consumption (kg/100 km) or Fuel Efficiency (km/kg)[1] ***and lower limit pressure of hydrogen (if applicable) (MPa)***	*Combined*
Final values FCc or FEc	
Final value P_{LL}	

Repeat 2.5.4. in case of base vehicle.

Paragraph 1.2.3.2., Annex B6, amend to read:

1.2.3.2. Depending on the vehicle type, the manufacturer shall declare as applicable the total cycle values of the CO2 emission, the electric energy consumption, fuel consumption, fuel efficiency as well as PER ~~and~~, AER **and P_{LL}** according to Table A6/1.

*Table A6/1, Annex B6, amend to rea*d:

Table A6/1

Applicable rules for a manufacturer's declared values (total cycle values)[a] (as applicable)

Powertrain		Level 1A M_{CO2} [b] *(g/km)*	Level 1A: *FC (kg/100 km)*	Level 1B; *FE (km/l or km/kg)*	*Electric energy consumption*[c] *(Wh/km)*	*All electric range / Equivalent all-electric range/ Pure Electric Range* [c] *(km)*	**Level ;1B Lower limit pressure (MPa)**
Vehicles tested according to Annex B6 (pure ICE)		M_{CO2} Paragraph 3. of Annex B7.	-	FE Paragraph 1.4. of Annex B7.	-	-	
NOVC-FCHV		-	FC_{CS} Paragraph 4.2.1.2.1. of Annex B8. .	FE_{CS} Paragraph 4.2.1.2.1. of Annex B8.	-	-	**P_{LL} Paragraph of 4.8.1 of Annex B8**
OVC-FCHV	CD	-	$FC_{,CD}$	N/A	$EC_{AC,CD}$	AER	
	CS	-	FC_{CS}	N/A	-	-	
	CD/CS weighted	-	-	-	-	EAER Paragraph 4.4.6.1. of Annex B8	

Powertrain		Level 1A M_{CO2} [b] *(g/km)*	Level 1A: *FC* *(kg/100 km)*	Level 1B; *FE (km/l or km/kg)*	*Electric energy consumption*[c] *(Wh/km)*	*All electric range / Equivalent all-electric range/ Pure Electric Range* [c] *(km)*	**Level ;1B Lower limit pressure (MPa)**
NOVC-HEV		$M_{CO2,CS}$ Paragraph 4.1.1. of Annex B8.	-	FE_{CS} Paragraph 4.1.1.1. of Annex B8.	-	-	
OVC-HEV	CD	$M_{CO2,CD}$ Paragraph 4.1.2. of Annex B8.	-	FE_{CD} Paragraph 4.6.1. of Annex B8.	For Level 1A: $EC_{AC,CD}$ Paragraph 4.3.1. of Annex B8.	AER Paragraph 4.4.1.1. of Annex B8.	
	CS	$M_{CO2,CS}$ Paragraph 4.1.1. of Annex B8.	-	FE_{CS} Paragraph 4.1.1.1. of Annex B8.	-	-	
	CD/CS weighted	-	-	-	For Level 1B: EC Paragraph 4.6.2. of Annex B8	EAER Paragraph 4.4.4.1. of Annex B8	
PEV		-	-	-	EC_{WLTC} Paragraph 4.3.4.2. of Annex B8.	PER_{WLTC} Paragraph 4.4.2. of Annex B8.	

(a) The declared value shall be the value to which the necessary corrections, as applicable, are applied
(b) Rounding to 2 places of decimal according to paragraph 6.1.8. of this Regulation
(c) Rounding to one place of decimal according to paragraph 6.1.8. of this Regulation

Table A6/2, Annex B6, amend to read:

Table A6/2
Criteria for number of tests
For NOVC-FCHVs and OVC-FCHVs in CS condition (as applicable)

	Test	*Judgement parameter*	For Level 1A: FC_{CS}	For Level 1B: FE_{CS}	**For Level 1B: P_{LL}**
Row 1	First test	First test results	≤ Declared value × 1.0	≥ Declared value × 1.0	**≤ Declared value × 1.0**
Row 2	Second test	Arithmetic average of the first and second test results	≤ Declared value × 1.0	≥ Declared value × 1.0	**≤ Declared value × 1.0**
Row 3	Third test	Arithmetic average of three test results	≤ Declared value × 1.0	≥ Declared value × 1.0	**≤ Declared value × 1.0**

Paragraph 3.5.3., Annex B8, amend to read:

3.5.3. Type 1 test procedure

3.5.3.1. Vehicles shall be tested according to the Type 1 test procedure described in Annex B6 and fuel consumption calculated according to **paragraph 1 and paragraph 2 of** Appendix 7 to this annex.

3.5.3.2. If required, fuel consumption shall be corrected according to Appendix 2 to this annex.

3.5.3.3. Driving range of hydrogen (DR_H) for NOVC-FCHV

3.5.3.3.1. The lower limit pressure of hydrogen tank shall be measured for NOVC - FCHVs according to paragraph 3 of appendix 7 to this annex.

3.5.3.3.2. Usable amount of hydrogen (UAH) shall be calculated according to paragraph 3 of appendix 7 to this annex.

3.5.3.3.3. Driving range of hydrogen shall be calculated with fuel efficiency and usable amount of hydrogen.

Paragraph 4., Annex B8, add new paragraph:

4.8 Calculation of driving range of hydrogen (DR_H) for NOVC-FCHVs

This paragraph is only applicable for Level 1B;

4.8.1 Stepwise procedure for calculating driving range of hydrogen for NOVC-FCHVs.

The results shall be calculated in the order described in Table A8/12. All applicable results in the column "Output" shall be recorded. The column "Process" describes the paragraphs to be used for calculation or contains additional calculations.

Table A8/12

Calculation of the driving range of hydrogen fuel for NOVC-FCHVs (for Level 1B only)

Step No.	*Source*	*Input*	*Process*	*Output*
1 **Result of single test**	**Paragraph 3.2 of appendix 7 to this annex.**	**The lower limit pressure of hydrogen tank**	**The lower limit pressure P_{LL} according to paragraph 3.2 of appendix 7 to this annex.**	**$P_{LL,1}$, MPa**
2	**Output step 1**	**For every test: $P_{LL,1}$, MPa**	**Averaging of tests and declared value according to paragraphs 1.2. to 1.2.3. inclusive of Annex B6.**	**$P_{LL,2}$, MPa**
3 **Result of P_{LL}**	**Output step 2**	**$P_{LL,2}$, MPa** **$P_{LL,\ declared}$, MPa**	**$P_{LL,2} = P_{LL,\ declared}$** **$P_{LL}$ values shall be rounded according to paragraph 6.1.8. of this Regulation.** **P_{LL} shall be rounded to the first place of decimal.**	**$P_{LL,3}$, MPa**
4 **Usable amount of hydrogen**	**Output step 3** **Paragraph 3.3 of appendix 7 to this annex.**	**$P_{LL,3}$, MPa**	**Usable amount of hydrogen according to paragraph 3.3 of appendix 7 to this annex.**	**UAH, kg**
5 **Result of driving range of hydrogen**	**Output step 4** **Output step 5 Table A8/7**	**UAH, kg** **$FE_{CS,c,5}$, km/kg**	**Calculation of driving range of hydrogen according to paragraph 4.8.2. of this annex.** **DR_H shall be rounded down to the nearest 20km.**	**DR_H, km**

4.8.2. **The driving range for NOVC-FCHVs shall be calculated as the following equations:**

$$DR_H = FE_{cs,c,5} \times UAH$$

For individual vehicles,

$$DR_{H-ind} = FE_{cs,c,ind} \times UAH$$

where

DR_H **is the driving range of the vehicle, km;**

$DR_{H\text{-}ind}$ **is the driving range for an individual vehicle, km;**

$FE_{CS,c,5}$ **is the charge-sustaining fuel efficiency determined according to step 5 of Table A8/7, km/kg**

$FE_{cs,c,ind}$ **is the charge-sustaining fuel efficiency for an individual vehicle determined according to step 6 of Table A8/7, km/kg**

UAH **is the usable amount of hydrogen, kg**

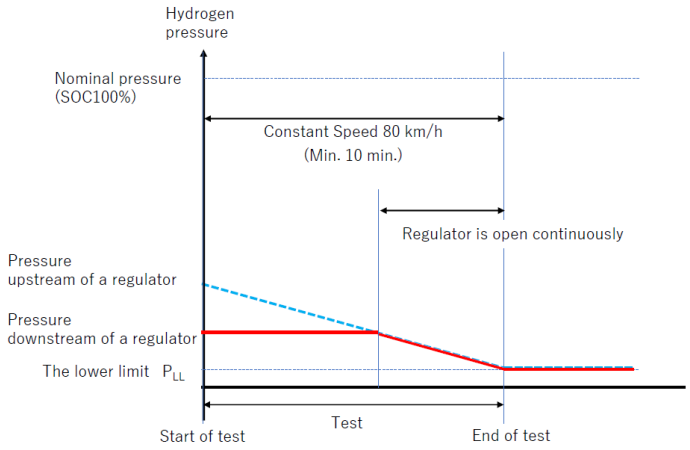
Annex B8 – Appendix 1, amend to read and add new clause 4:

REESS state of charge profile **and hydrogen state of charge profile**

4. **Test sequence NOVC-FCHVs the lower limit pressure test (Figure A8.App1/8)**

Figure A8.App1/8

NOVC-FCHVs, the lower limit pressure test



Annex B8 – Appendix 7, amend to read and add new clause 3:

Annex B8 - Appendix 7

Fuel consumption **and usable amount of hydrogen** measurement of compressed hydrogen fuel cell hybrid vehicles

1. General requirements

Fuel consumption shall be measured using the gravimetric method in accordance with paragraph 2. of this appendix.

At the request of the manufacturer and with approval of the responsible authority, fuel consumption may be measured using either the pressure method or the flow method. In this case, the manufacturer shall provide technical evidence that the method yields equivalent results. The pressure and flow methods are described in ISO 23828.

Usable amount of hydrogen shall be measured in accordance with paragraph 3. of this appendix.

2. Gravimetric method

3. Usable amount of hydrogen

This paragraph is only applicable for Level 1B;

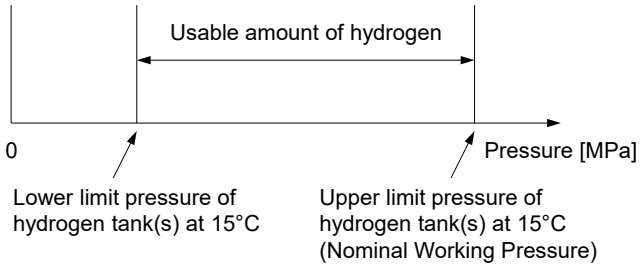
This test may be carried out after the fuel consumption test.

3.1 Principles

Usable amount of hydrogen is defined as shown in the figure A8/x. The lower limit pressure of hydrogen tank is the pressure when the vehicle stops running because of interruption of hydrogen supply.

Figure A8.App7/2

Schematic diagram of "usable amount of hydrogen

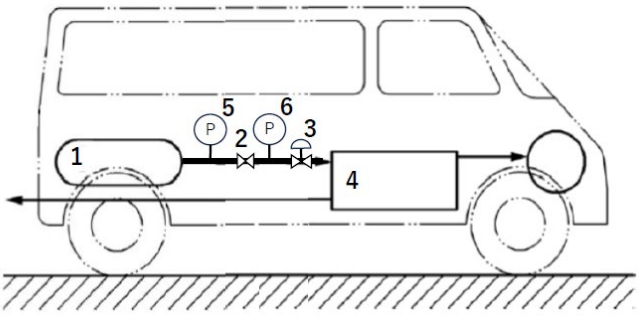


3.2 Measurement of lower limit pressure of hydrogen tank(s)

The lower limit pressure of hydrogen tank(s) shall be measured.

Figure A8.App7/3

Example of measuring pressure of hydrogen tank(s)



1: is the hydrogen tank(s)

2: is the pressure regulator

3: is the control valve to supply hydrogen to fuel cell system

4: is the fuel cell system

5: is the pressure sensor upstream of a pressure regulator

6: is the pressure sensor downstream of a pressure regulator

In the case that a vehicle was tested for measurement of lower limit pressure of hydrogen tank(s), the lower limit pressure may be applied to vehicles that fulfil the same family of Lower limit pressure defined in paragraph 6.3.12. of this regulation.
Vehicle H shall be tested when a vehicle was selected from an interpolation family as defined in paragraph 6.3.12.(b) of this regulation.

3.2.1. Units, accuracy and resolution

Units, accuracy and resolution of measurements shall be as shown in Table A8.App7/3.

At the request of the manufacturer and with approval of the responsible authority, the on-board pressure sensor may be used.

Table A8.App7/3 Parameters, units, accuracy and resolution of measurements

Parameter	*Units*	*Accuracy*	*Resolution*

Pressure of the hydrogen tank	MPa	±1 MPa	0.1 MPa

3.2.2. Equipment and setting

The pressure of the on-board hydrogen tank(s) shall be adjusted to the manufacturer's recommended value to meet the requirement of the minimum driving time in the paragraph 3.5.

3.2.3. The test cell temperature at the start of the test shall be within ± 5 °C of the set point of 23 °C. The test vehicle shall be pushed onto a dynamometer.

3.2.4. Vehicle preparation

3.2.4.1. Soaking

The test vehicle shall be soaked for a minimum of 6 hours before the test. However soaking may be omitted in following cases.

- Temperature sensors of on-board tank(s) are applicable, and the temperatures are already within ±5 °C of 23 °C.
- The test is carried out to follow Type 1 in the test cell where the temperature has been kept within ±5 °C of 23 °C.

3.2.4.2. When a test vehicle of this test is not used for Type 1 test of fuel consumption described in paragraph 1 and paragraph 2 of this appendix, at the request of manufacturer, run-in requirement of paragraph 2.2 of this annex and preconditioning described in paragraph 2.6.4.3. of annex B6 may be omitted.

3.2.5. Constant speed

The minimum speed of the constant speed segments shall be set to 80 km/h. At the request of manufacturer and with approval of the responsible 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 initiating the powertrain start procedure.

The vehicle shall be driven more than 10 minutes in the constant speed segments.

The pressure of the hydrogen tank(s) shall be measured at a sampling rate of a least 5 Hz.

3.2.6. Break-off criterion

The break-off criterion is as follows;

(a) when the vehicle exceeds the prescribed speed trace tolerance as specified in paragraph 2.6.8.3.1.2. of Annex B6 for 4 consecutive seconds or more;

(b) or when manufacturer declares the end of the constant speed segment.

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

3.3. Calculation of the Usable amount of hydrogen (UAH)

3.3.1. Equation of UAH

The pressure and if applicable the temperature of the hydrogen tank(s) at the end of the constant speed segment shall be employed for calculation of the usable amount of hydrogen.

The usable amount of hydrogen is calculated by using the following equation:

UAH = V × (ρ[P_{NWP}, T15] – ρ[P_{LL}, T15]) / 1 000

where:

UAH **is the usable amount of hydrogen, expressed in kg;**

V **is the volume of hydrogen tank(s), expressed in m^3;**

ρ[P_{NWP}, T15] **is the gas density at the given pressure and temperature for 100% of SOC, g/m^3;**

P_{NWP} **is the gas pressure at the nominal working pressure, Mpa;**

T15 **is 283,15 K (15 °C) as reference temperature of the nominal working pressure;**

P_{LL} **is the lower limit pressure measured in the test, expressed in MPa.**

Nominal working pressure and volume of hydrogen tank(s) are specified by the report of Model I, Annex 1 Part 1, UN R134. The total volume is applied if multiple tanks are loaded on the vehicle.

Gas density of hydrogen is determined by the following equation.

$$\rho(p,T) = \frac{pM}{RT}\left(\frac{1}{Z(p,T)}\right)$$

where:

ρ[*p*, *T*] **is the gas density at the given pressure and temperature, g/m^3;**

p **is the pressure of the hydrogen tank at the end of the constant speed segment, MPa**

T **is hydrogen gas temperature of the hydrogen tank. 283,15 (15 °C) in K at the end of the constant speed segment.**

R **is the gas constant, 8.314472x 10^{-6}in m^3 MPa K^{-1} mol^{-1};**

M **is the molar mass of hydrogen, 2.01588, g/mol;**

***Z*(*p*,*T*)** **is the compressibility factor.**

The Compressibility factors of hydrogen gas are listed in Table A7/2 to annex B7.

3.3.2. **Simplified approach to calculate UAH for 70MPa system**

When P_{NWP} is 70MPa, the density of hydrogen can be derived from the equations above.

ρ[70MPa, 15°C] = 40.22×10^3 (g/m^3)

At the request of manufacturer, the density of hydrogen of the tank(s) at the end of the constant speed segment and UAH may be derived from approximate equations as follows,

$$Z(pLL, 15°C) = 1$$

$$\rho(pLL, 15°C) = \frac{PLL\times M(\frac{g}{mol})}{RT} = 8.4\times10^2\times P_{LL}(MPa)$$

UAH = V × ($40.17\times10^3 - 8.4\times10^2\times P_{LL}$) / 1 000

II. Justification

1. Addition of driving range test for NOVC-FCHV for user information due to the limited number of hydrogen stations (This proposal is limited to Level 1B.).

2. On the other hand, Japan understands that the frequent amendments of this Regulation is not efficient from the viewpoint of UNECE amendment process and homologation process in each region. Therefore, Japan follows GRPE decision if this amendment would be voted at WP.29 as a consolidated document including the other amendments yet to come in the near future.

<DF unit>

7.1. A multiplicative exhaust emission deterioration factor shall be calculated for each pollutant as follows:

$$D.E.F. = \frac{Mi_2}{Mi_1}$$

Where:

Mi_1 =

For Level 1A mass emission of the pollutant i in g/km (#/km in case of particle number) interpolated to 5,000 km,

For Level 1B - mass emission of the pollutant i in g/km (#/km in case of particle number) extrapolated to 3,000 km

Mi_2 = mass emission of the pollutant i in g/km (#/km in case of particle number) interpolated to the target useful life

These interpolated values shall be carried out to a minimum of four places to the right of the decimal point before dividing one by the other to determine the deterioration factor. The result shall be rounded to three places to the right of the decimal point.

If a deterioration factor is less than one, it is deemed to be equal to one.

At the request of a manufacturer, an additive exhaust emission deterioration factor shall be calculated for each pollutant as follows:

$D . E . F . = Mi_2 – Mi_1$

If the additive deterioration factor calculated with the above formula is negative, then it shall be put equal to zero.

These additive deterioration factors shall follow the same rules described for the multiplicative deterioration factors in relation to Level 1A (4 phase WLTP) and Level 1B (3 phase WLTP).