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Electric Vehicles and the Environment (EVE)

UN GTRs Nos. 21 (DEVP) and

[XX] on in-vehicle battery durability

### Proposal for a new UN GTR on In-vehicle Battery Durability for Electrified Vehicles

Submitted by the Informal Working Group on Electric Vehicles and  
the Environment (EVE)\*

The text reproduced below was prepared by the Informal Working Group (IWG) on Electric Vehicles and the Environment (EVE) following the authorization given by WP.29/AC.3 in June 2020 to develop this UN GTR (ECE/TRANS/WP.29/AC.3/57). A first draft of this proposal was made available as an informal document by the EVE IWG at the 82nd session of GRPE (see informal document GRPE-82-27).

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\* In accordance with the programme of work of the Inland Transport Committee for 2021 as outlined in proposed programme budget for 2021 (A/75/6 (Sect.20), para 20.51), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.



# Proposal for a new UN GTR on In-vehicle Battery Durability for Electrified Vehicles

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## I. Statement of technical rationale and justification

[To be prepared]

## II. Text of the GTR

### 1. Purpose

This Global Technical Regulation provides a worldwide harmonized method to set and verify minimum performance requirement on in-vehicle battery durability of Pure Electric Vehicles (PEVs) and Off-vehicle Charging Hybrid Electric Vehicles (OVC-HEVs).

### 2. Scope and application

This UN GTR applies to PEV and OVC-HEV vehicles of categories 1-2 and 2, both having a technically permissible maximum laden mass not exceeding 3,855 kg, and to all vehicles of category 1-1.

At the option of the Contracting Party, the scope may be limited to 3,500 kg for the relevant categories.

While manufacturers commonly estimate or publicise other range-based metrics for informational purposes (such as, for example, an in-use range under real driving conditions, or the remaining range available before the next charging event), the range-related provisions of this GTR are concerned only with the certified range as would be measured by the applicable certification test procedure.

The authorities shall take a decision for what concerns the application of this GTR to Small Volume Manufacturers.

### 3. Definitions

The following definitions shall apply in this Global Technical Regulation.

[3.x. "Battery" means a rechargeable electrical energy storage system (REESS) installed in an electrified vehicle.

3.x. "Usable Battery energy (UBE)" means the energy supplied by the battery from the beginning of the test procedure used for certification until the applicable break-off criterion of the test procedure used for certification is reached. For PEVs, UBE is defined in the certification test procedure by the Contracting Party. For OVC-HEVs, UBE is not defined in the certification test procedure of the Contracting Parties but shall be determined as follows:

$$UBE_{OVC-HEV} = \sum_{j=1}^{n+1} \Delta E_{REESS,j}$$

$\Delta E_{REESS,j}$  is the electric energy change of all REESSs

j is the index number of the applicable test cycle according to the certification test procedure of the Contracting Party

n+1 is the number of cycles from the beginning of the test procedure until the confirmation cycle or the charge-balanced cycle, as defined by the Contracting Party, is reached. In the confirmation cycle or charge-balanced cycle, the energy balance shall be

considered and corrected to a charging balance neutral energy balance.

- 3.x. *"Certified usable battery energy"* refers to the UBE that was determined during the certification of the vehicle.
- 3.x. *"Measured usable battery energy"* means the UBE determined at the present point in the lifetime of the vehicle by the test procedure used for certification.
- 3.x. *"Electric Range"* refers to the range that would be determined by the range test procedure used for certification of the vehicle, if the test was performed at the present point in the lifetime of the vehicle and the originally installed battery.

For pure electric vehicles (PEVs), the applicable range is the electric range as defined in the certification procedure by the Contracting Parties, e.g. PER as defined in UN GTR No. 15 or AER as defined in US regulations.

For OVC-HEVs, the applicable range is the equivalent all-electric range (EAER) calculated as follows (shown by a generic calculation scheme):

$$EAER = \left( \frac{A - B}{A} \right) \times C$$

Where:

- A is the charge-sustaining CO<sub>2</sub> mass emission of the Charge-Sustaining Test (called CS-test in UN GTR No. 15 and CST in US regulation)
- B is the arithmetic average of the charge-depleting CO<sub>2</sub> mass emissions of all driven cycles in the Charge-Depleting Test (CD-Test as defined in UN GTR No. 15) or in the Full-Charge Test (FCT as defined in the US regulation)
- C is the distance from the beginning of the Charge-Depleting Test or Full-Charge Test to the end of the last cycle prior to the cycle or cycles satisfying the break-off criterion, including the transition cycle where the vehicle may have operated in both depleting and sustaining conditions.
- 3.x. *"Certified range"* refers to the electric driving range that was determined during certification of the vehicle.
- 3.x. *"Measured range"* means the electric range determined at the present point in the lifetime of the vehicle by the test procedure used for certification.
- 3.x. *"Rechargeable electrical energy storage system"* (REESS) means a propulsion energy storage system that stores electrical energy and which is rechargeable. A battery whose primary use is to supply power for starting the engine and/or lighting and/or other vehicle auxiliaries systems is not considered as a REESS for the purposes of this GTR. The REESS may include the necessary ancillary systems for physical support, thermal management, electronic controls and casing.
- 3.x. *"State of certified energy"* (SOCE) means the measured or estimated UBE performance at a specific point in its lifetime, expressed as a percentage of the certified usable battery energy.
- 3.x. *"State of certified range"* (SOCR) means the measured or estimated electric range at a specific point in its lifetime, expressed as a percentage of the certified range.
- 3.x. *"Minimum Performance Requirement"* (MPR) means the minimum durability performance, in terms of SOCE or SOCR at a specific point in the life of the vehicle, that constitutes compliance with the durability provisions of this GTR.
- 3.x. *"Declared Performance Requirement"* (DPR) means an SOCE or SOCR value declared by the manufacturer that is greater than that of the corresponding

MPR and which then becomes the minimum durability performance that constitutes compliance of that manufacturer with the durability provisions of this GTR.

- 3.x. "SOCR monitor" means an apparatus installed in the vehicle that maintains an estimate of the state of certified range by means of an algorithm operating on data collected from the vehicle systems.
- 3.x. "SOCE monitor" means an apparatus installed in the vehicle that maintains an estimate of the state of certified energy by means of an algorithm operating on data collected from the vehicle systems.
- 3.x. "Estimated SOCR" means an estimate of state of certified range produced by an SOCR monitor.
- 3.x. "Estimated SOCE" means an estimate of state of certified energy produced by an SOCE monitor.
- 3.x. "Measured SOCR" means the state of certified range as determined by the measured range divided by the certified range.
- 3.x. "Measured SOCE" means the state of certified energy as determined by the measured usable battery energy divided by the certified usable battery energy.

to be completed, including the numbering and ordering of definitions by category.]

#### **4. Abbreviations**

[SOCE                      State of Certified Energy

SOCR                      State of Certified Range

To be completed]

#### **5. Requirements**

- 5.1. State-of-Certified Range and State-of Certified Energy (SOCR and SOCE) monitors

The manufacturer shall install SOCR and SOCE monitors that operate during the life of the vehicle. The SOCR monitor shall maintain an estimate of the state of certified range (estimated SOCR), and the SOCE monitor shall maintain an estimate of the state of certified energy (estimated SOCE).

The manufacturer shall determine the algorithms by which estimated SOCR and estimated SOCE are determined for the vehicles they produce. The manufacturer shall update the estimated SOCR and SOCE with sufficient frequency as to maintain the necessary degree of accuracy during all normal vehicle operation. As defined in Annex 2, in cases when the monitor would not have appropriate data to produce an accurate value or when the vehicle was abnormally used, the monitor shall distinguish these cases and put a flag on the values read.

The estimated SOCR and SOCE shall be rounded to the [nearest whole number/first decimal place] according to paragraph 7 of this GTR.

The manufacturer shall make available the most recently determined values of the estimated SOCR and estimated SOCE via the OBD port and optionally over-the-air (OTA).

For the purposes of consumer information, the manufacturer shall make easily available to the owner of the vehicle the most recently determined value of the SOCE monitor via at least one appropriate method. For example:

- (a) dashboard indicator;

- (b) infotainment system;
- (c) remote access (such as via mobile-phone applications).

5.2. Battery Performance Requirements

The battery durability requirements of this GTR are defined in terms of Minimum Performance Requirements (MPR<sub>i</sub>), which represent minimum allowable values for SOCE and SOCR at specific points in the lifetime of the vehicle. Vehicles falling under the categories of OVC-HEVs and PEVs shall meet both of the Minimum Performance Requirements in Tables 1 and 2 below. The MPRs may differ depending on the category of the vehicle and propulsion.

In order to address regional considerations, a Contracting Party may optionally elect to enforce only one of the two Minimum Performance Requirements (MPR<sub>i</sub>) in each of the tables below (i.e. either the one ending at 5 years or 100,000 km, or the one ending at 8 years or 160,000 km). In the second case, the values shall apply from the start of the life of a vehicle up to 8 years or 160,000 km, whichever comes first.

Table 1  
**Battery Energy based (SOCE) MPR**

<i>Vehicle age/km for categories 1-1 and 1-2 in the scope of this GTR</i>	<i>OVC-HEV</i>	<i>PEV</i>
From start of life to 5 years or 100,000 km, whichever comes first	[80%]	[80%]
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	[70%]	[70%]
<hr/>		
<i>Vehicle age/km for category 2 in the scope of this GTR</i>	<i>OVC-HEV</i>	<i>PEV</i>
From start of life to 5 years or 100,000 km, whichever comes first	[reserved]	[reserved]
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	[reserved]	[reserved]

Table 2  
**Range based (SOCR) MPR**

<i>Vehicle age/km for categories 1-1 and 1-2 in the scope of this GTR</i>	<i>OVC-HEV</i>	<i>PEV</i>
From start of life to 5 years or 100,000 km, whichever comes first	[reserved]	[reserved]
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	[reserved]	[reserved]
<hr/>		
<i>Vehicle age/km for category 2 in the scope of this GTR</i>	<i>OVC-HEV</i>	<i>PEV</i>
From start of life to 5 years or 100,000 km, whichever comes first	[reserved]	[reserved]
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	[reserved]	[reserved]

SOCR and SOCE monitors of vehicles of category 2 and SOCR monitors of category 1-1 and 1-2 vehicles shall be monitored in view of setting the values in the tables in a future amendment of this GTR.

A manufacturer may elect to declare a Declared Performance Requirement (DPRi) having an SOCE and/or SOCR value that is higher than that of the corresponding MPR. The DPRi will then replace the MPRi for the purposes of determining compliance by that manufacturer.

The manufacturer shall ensure that batteries installed in vehicles will perform equal or better than the MPRi (or DPRi if applicable).

## 6. In-Use Verification

### 6.1. Definitions of Families

Vehicles having the same characteristics with respect to their evaluation under Part A or Part B below shall be grouped into vehicle families for the purpose of compliance verification. Families under Part A shall have the same characteristics with respect to verification of the SOCR/SOCE monitors. Families under Part B shall have the same characteristics with respect to verification of battery durability [and shall be subsets of Part A families]. Families with the same characteristics for what regards compliance verification shall be defined as follows:

#### 6.1.1. For Part A: Verification of Monitors

Only vehicles that are identical with respect to the following elements may be part of the same monitor family:

- [(a) Algorithm for estimating SOCR and SOCE, and for determining flag conditions described in Annex 2, including software version\*
- (b) Sensor configuration (for sensors providing data used in determination of SOCR and SOCE estimates and flag conditions)
- (c) Type and dimension of cell (including format and chemistry)
- (d) Battery management system (BMS)\* (with regards to battery durability monitoring and estimations)
- (e) Type of vehicle (PEVs or OVC-HEVs)

to be completed]

\* At the request of the manufacturer and the approval of the responsible authority the monitor family may be extended in the case of a different algorithm or BMS if there is sufficient evidence that the performance of the monitor will not be affected.

#### 6.1.2. For Part B: Verification of Battery Durability

Only vehicles that are identical with respect to the following electric powertrain/transmission characteristics may be part of the same battery durability family:

- [(a) Type and number of electric machines: construction type (asynchronous/ synchronous, etc.), type of coolant (air, liquid), method of cooling and any other characteristics having a non-negligible influence on battery durability;
- (b) Type of traction REESS (dimensions, type of cell, including format and chemistry, capacity (Ampere-hour), nominal voltage, nominal power, type of coolant (air, liquid);
- (c) Battery management system (BMS) (with regards to battery durability monitoring and estimations);

- (d) Insulation/packaging of the battery;
- (e) Transmission type (e.g. manual, automatic, CVT) and transmission model (e.g. torque rating, number of gears, numbers of clutches, etc.);
- (f) Number of powered axles;
- (g) Type of electric energy converter between the electric machine and traction REESS, between the recharge-plug-in and traction REESS, and any other characteristics having a non-negligible influence on battery durability;
- (h) Operation strategy of all components influencing the battery durability;
- (i) 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.]

With the approval of the responsible authority, the manufacturer may deviate from the above criteria for families, with appropriate technical justification.

## 6.2. Information gathering

The following information shall be made available to the authorities by the manufacturer: annual report on relevant warranty claims; and annual statistics on repairs for both batteries and other systems that might influence the electric energy consumption of the vehicle.

## 6.3. Part A: Verification of SOCR/SOCE monitors

### 6.3.1. Frequency of verifications

The manufacturer shall complete the procedure for in-use verification for Part A with a frequency agreed with the authorities, until 5 or 8 years as defined in paragraph 5.2. after the last vehicle of each monitor family is sold and report the results of the verification to the authorities. The authorities may decide to proceed with their own verification of Part A, at a frequency and magnitude based on risk assessment, or request more information from the manufacturers.

[The verification of the monitors shall not be mandatory if the annual sales of the monitor family are less than 5,000 vehicles in the market for the previous year. Such in-service conformity families may still be selected to be tested for Part A, at the request of the responsible authorities.]

### 6.3.2. Verification procedure

In order to verify the SOCR/SOCE monitors, the values for range and battery usable energy shall be measured at the time of the verification and the related values from the monitors read. In cases where the either monitor is reporting a flag for not being able to monitor accurately according to Annex 2, Cases A, then these vehicles shall be corrected, according to the instructions of the manufacturer, until the flag disappears and then tested. The manufacturer shall provide instructions on what is required to make the monitor able to provide an accurate value.

The measured SOCR and measured SOCE values shall be determined by dividing the measured values for range and usable battery energy by the certified values for range and usable battery energy, respectively and rounded to the nearest [whole number/first decimal place] according to paragraph 7 of this GTR, expressed in %.

$$SOCE_{measured} = \frac{UBE_{measured}}{UBE_{declared}} * 100$$

$$SOCR_{measured} = \frac{Range_{measured}}{Range_{declared}} * 100$$



6.3.3. Pass/Fail decision for a vehicle test

6.3.3.1. Pass decision

A vehicle test shall be considered a pass (p) when the estimated SOCR and estimated SOCE read from the vehicle are both not more than 5 percentage points greater than the respective measured value.

6.3.3.2. Fail decision

A vehicle test shall be considered a fail (f) when either the estimated SOCR or the estimated SOCE read from the vehicle are more than 5 percentage points greater than the respective measured value.

6.3.4. Statistical Method for Pass/Fail decision for a sample of vehicles

Separate statistics shall be calculated for the SOCR monitor and the SOCE monitor.

An adequate number of vehicles shall be selected from the same monitor family for testing following a vehicle survey (see Annex 1) containing information designed to ensure that the vehicle has been properly used and maintained according to the specifications of the manufacturer. The following statistics shall be used to take a decision on the accuracy of the monitor.

[To be defined as one from the following options:

Option A: For the purposes of deciding on a pass/fail result for the sample, 'p' is the count of passed results, and 'f' is the count of failed results. Each passed test result shall increase the 'p' count by 1 and each failed test result shall increase the 'f' count by 1 for the relevant open statistical procedure.

Upon the incorporation of valid SOCR/SOCE test results to an open instance of the statistical procedure, the responsible authority shall perform the following actions:

- (a) update the cumulative sample size 'n' for that instance to reflect the total number of valid tests incorporated to the statistical procedure;
- (b) following an evaluation of the results, update the count of passed results 'p' and the count of failed results 'f';
- (c) check whether a decision is reached with the procedure described below.

The decision depends on the cumulative sample size 'n', the passed and failed result counts 'p' and 'f'. For the decision on a pass/fail of a verification sample the responsible authority shall use the decision chart in Figure 1. The charts indicate the decision to be taken for a given cumulative sample size 'n' and failed count result 'f'.

Two decisions are possible for a statistical procedure for a given vehicle family:

- (a) 'Sample pass' outcome shall be reached when the decision chart from Figure 1 gives a "PASS" outcome for the current cumulative sample size 'n' and the count of failed results 'f'.
- (b) 'Sample fail' decision shall be reached when, for a given cumulative sample size 'n', when the applicable decision chart from Figure 1 gives a "FAIL" decision for the current cumulative sample size 'n' and the count of failed results 'f'.

If no decision is reached, the statistical procedure shall remain open and further results shall be incorporated into it until a decision is reached.

Option A1:

Figure 1  
Decision chart for the statistical procedure (where 'UND' means undecided)

failed result count f	10							FAIL
	9						FAIL	FAIL
	8					FAIL	FAIL	FAIL
	7				FAIL	FAIL	FAIL	FAIL
	6			FAIL	FAIL	FAIL	FAIL	FAIL
	5		FAIL	FAIL	FAIL	UND	UND	PASS
	4	FAIL	FAIL	UND	UND	UND	UND	PASS
	3	FAIL	FAIL	UND	UND	UND	UND	PASS
	2	UND	UND	UND	UND	PASS	PASS	PASS
	1	UND	PASS	PASS	PASS	PASS	PASS	PASS
	0	PASS	PASS	PASS	PASS	PASS	PASS	PASS
	3	4	5	6	7	8	9	10

**Cumulative sample size n**

Option A2: Another possibility is the table from UN Regulation No. 83, 07 series of amendments, which is based on International Standard ISO 8422:1991. See Table 3.

Table 3  
Table for acceptance/rejection sampling plan by attributes

Cumulative sample size (n)	Pass decision number	Fail decision number
3	0	-
4	1	-
5	1	5
6	2	6
7	2	6
8	3	7
9	4	8
10	4	8
11	5	9
12	5	9
13	6	10
14	6	11
15	7	11
16	8	12
17	8	12
18	9	13
19	9	13
20	11	12

Option B:

**Part A: Verification of SOCR/SOCE monitors**

An adequate number of vehicles (at least 3 and not more than 16) shall be selected from the same monitor family for testing following a vehicle survey (see Annex 1) containing information designed to ensure that the vehicle has

been properly used and maintained according to the specifications of the manufacturer. The following statistics shall be used to take a decision on the accuracy of the monitor.

For evaluating the SOCR/SOCE monitors normalised values shall be calculated:

$$x_i = \frac{SOC_{read,i}}{SOC_{measured,i}}$$

Where

$SOC_{read,i}$  is the SOCR/SOCE monitor read from the vehicle  $i$  ; and

$SOC_{measured,i}$  is the measured SOCR/SOCE monitor of the vehicle  $i$ .

For the total number of  $N$  tests and the normalised values of the tested vehicles,  $x_1, x_2, \dots, x_N$ , the average  $X_{tests}$  and the standard deviation  $s$  shall be determined:

$$X_{tests} = \frac{(x_1 + x_2 + x_3 + \dots + x_N)}{N}$$

and

$$s = \sqrt{\frac{(x_1 - X_{tests})^2 + (x_2 - X_{tests})^2 + \dots + (x_N - X_{tests})^2}{N - 1}}$$

For each number of tests  $3 \leq N \leq 16$ , one of the three following decisions can be reached, where the factor  $A$  shall be set at [1.01]:

- (a) Pass the family if  $X_{tests} \leq A - (t_{P1,N} + t_{P2,N}) \cdot s$
- (b) Fail the family if  $X_{tests} > A + (t_{F1,N} - t_{F2}) \cdot s$
- (c) Take another measurement if:

$$A - (t_{P1,N} + t_{P2,N}) \cdot s < X_{tests} \leq A + (t_{F1,N} - t_{F2}) \cdot s$$

where the parameters  $t_{P1,N}$ ,  $t_{P2,N}$ ,  $t_{F1,N}$ , and  $t_{F2}$  are taken from Table 4.

Table 4  
Pass/fail decision number for the sample size

Tests (N)	PASS		FAIL	
	$t_{P1,N}$	$t_{P2,N}$	$t_{F1,N}$	$t_{F2}$
3	1.686	0.438	1.686	0.438
4	1.125	0.425	1.177	0.438
5	0.850	0.401	0.953	0.438
6	0.673	0.370	0.823	0.438
7	0.544	0.335	0.734	0.438
8	0.443	0.299	0.670	0.438
9	0.361	0.263	0.620	0.438
10	0.292	0.226	0.580	0.438
11	0.232	0.190	0.546	0.438
12	0.178	0.153	0.518	0.438
13	0.129	0.116	0.494	0.438
14	0.083	0.078	0.473	0.438
15	0.040	0.038	0.455	0.438
16	0.000	0.000	0.438	0.438

]

6.3.5. Corrective measures for the SOCR and SOCE monitors

A fail decision for the sample means that the monitors fail to report accurately the durability of the system and appropriate action shall be taken by the manufacturer with the agreement of the responsible authority. This may lead to the requirement that the manufacturer brings all vehicles in the same monitor family in conformity by repairing or replacing the faulty monitor including the relevant sensors or applying software measures.

A pass decision or correction of the non-conformity is required for proceeding with Part B.

6.4. Part B: Verification of Battery Durability

6.4.1. Frequency of verifications

Data shall be collected yearly by the authorities from a statistically adequate sample of vehicles within the same battery durability family. The decision on the number of the vehicles in the sample may be taken by the responsible authority based on risk assessment methodology, but in principle should not be less than [500].

If the number of vehicles in the sample is less than [500], then presence of a flag of the monitor triggered by Cases B of Annex 2 shall be used to decide whether the vehicle has been abnormally used and therefore should be excluded from the sample.

All vehicles with a flag of the monitor according to Annex 2, Cases A shall be excluded from the sample.

The data read shall be those of the SOCR and SOCE monitors (and other relevant data, such as the flags according to Annex 2). SOCR and SOCE monitors of vehicles of category 2 and SOCR monitors of category 1-1 and 1-2 vehicles shall be monitored.

6.4.2. Pass/Fail Criteria for the battery durability family

A battery durability family shall pass if equal or more than [90 per cent] of monitor values read from the vehicle sample are above the MPRi or DPRi.

A battery durability family shall fail if less than [90 per cent] of monitor values read from the vehicle sample are below the MPRi or DPRi.

The percentage from the vehicle sample shall be rounded to the [nearest whole number/first decimal place] according to paragraph 7 of this GTR.

6.4.3. Corrective Measures for the Battery Durability Family

In case of a fail for a battery durability family, corrective measures shall be taken with the agreement of the responsible authority in order to bring the family or part of the family affected by the issue in conformity.

## 7. Rounding

7.1. When the digit immediately to the right of the last place to be retained is less than 5, that last digit retained shall remain unchanged.

Example:

If a result is 1.234 grams but only two places of decimal are to be retained, the final result shall be 1.23 grams.

7.2. When the digit immediately to the right of the last place to be retained is greater than or equal to 5, that last digit retained shall be increased by 1.

Example:

If a result is 1.236 grams but only two places of decimal are to be retained, and because 6 is greater than 5, the final result shall be 1.24 grams.

## Annex 1

### Vehicle Survey

The vehicle survey shall be used for all vehicles selected for testing in Part A of the verification.

	x = Exclusion Criteria	x = Checked and reported	Confidential
<b>Date:</b>			x
<b>Name of investigator:</b>			x
<b>Location of test:</b>			x
<b>Country of registration:</b>		x	

Vehicle Characteristics	x = Exclusion Criteria	x = Checked and reported	Confidential
<b>Registration plate number:</b>		x	x
<b>Mileage:</b> <i>The vehicle must have mileage and age (defined as the time elapsed after first registration) below the one required in Section 5.2 for the MPR verification</i>	x		
Is the vehicle either PHEV or BEV?	x		
<b>Date of first registration:</b>		x	

<b>VIN:</b>		x	
<b>Emission class and character or Model Year</b>		x	
<b>Country of registration:</b> <i>The vehicle must be registered in a CP</i>	x	x	
<b>Model:</b>		x	
<b>Engine code:</b>		x	
<b>Engine volume (l):</b>		x	
<b>Engine power (kW):</b>		x	
<b>Electric Engine code:</b>		x	
<b>Electric Engine power (kW):</b>		x	
<b>Electric powertrain type</b>		x	
<b>Energy capacity and type of battery</b>		x	
<b>Gearbox type (auto/manual):</b>		x	
<b>Drive axle (FWD/AWD/RWD):</b>		x	
<b>Tyre size (front and rear if different):</b>		x	
<b>Average fuel consumption for PHEVs</b>		x	
<b>Is the vehicle involved in a recall or service campaign?</b> <b>If yes: Which one? Have the campaign repairs already been done?</b> <i>The repairs must have been done before selecting the vehicle.</i>	x	x	

**Vehicle Owner Interview**

(the owner will only be asked the main questions and shall have no knowledge of the implications of the replies)

<b>Name of the owner (only available to the accredited inspection body or laboratory/technical service)</b>			X
<b>Contact (address / telephone) (only available to the accredited inspection body or laboratory/technical service)</b>			X
<b>How many owners did the vehicle have?</b>		X	
<b>Did the odometer work?</b> <i>If no, the vehicle cannot be selected.</i>	X		
<b>Was the vehicle used for one of the following?</b>			
As car used in show-rooms?		X	
As a taxi?		X	
As a delivery vehicle?		X	
For racing / motor sports?	X		
As a rental car?		X	
<b>Has the vehicle carried heavy loads over the specifications of the manufacturer?</b> <i>If yes, the vehicle cannot be selected.</i>	X		
<b>Have there been major engine, electric motor or vehicle repairs?</b>		X	
<b>Have there been unauthorised major engine or vehicle repairs?</b> <i>If yes, the vehicle cannot be selected.</i>	X		
<b>Was the propulsion battery changed or repaired?</b> <i>If yes the vehicle cannot be selected for testing, but information should be collected</i>	X		X
<b>Has there been an unauthorised power increase/tuning?</b> <i>If yes, the vehicle cannot be selected.</i>	X		
<b>Was any part of the emissions after-treatment system modified?</b> <i>If yes, the vehicle cannot be selected</i>	X		
<b>Where do you use your vehicle more often?</b>			
% motorway	-	-	-
% rural	-	X	-
% urban	-	X	-
<b>Has the vehicle been maintained and used in accordance with the manufacturer's instructions?</b> <i>If not, the vehicle cannot be selected.</i>	X		
<b>Full service and repair history including any re-works</b> <i>If the full documentation cannot be provided, the vehicle cannot be selected.</i>	X		
<b>Battery related checks: (Indicating Normal Use)</b>			
<b>How often did you charge the vehicle when:</b>			
%with battery almost at 0 charge	-	X	
%with battery half charged	-	X	
%with battery almost fully charged	-	X	

<b>On average how often were fast or superfast chargers used in a month?</b> <b>What is your estimation of the percentage of time that the vehicle was used in the following ambient temperature ranges:</b> <p style="text-align: right;"><b>Below -7C:</b>  <b>Between -7C and 35C:</b>  <b>More than 35C:</b></p>		x	
<b>[What percentage of time was the vehicle used for V2G or other similar non-propulsion purposes, including but not limited to home back-up, charging another vehicle, or for grid services?]</b>		x	
<b>Was the vehicle stored and not used for more than one full month during its life? If so, how many times per year?</b>		x	

x=  
Exclusion  
Criteria

x=checked  
and  
reported

Relevant  
for BEV

**Vehicle Examination and Maintenance (please use the relevant entries according to the type of vehicle)**

<b>Fuel tank level (full / empty)</b> Is the fuel reserve light ON? <i>If yes, refuel before test.</i>		x	
<b>Are there any warning lights on the instrument panel activated indicating a vehicle or exhaust after-treatment system malfunctioning that cannot be resolved by normal maintenance? (Malfunction Indication Light, Engine Service Light, etc?)</b> <i>If yes, the vehicle cannot be selected</i>	x		
<b>Is the SCR light on after engine-on?</b> <i>If yes, the reagent should be filled, or the repair executed before the vehicle is used for testing.</i>	x		
<b>Visual inspection exhaust system</b> Check leaks between exhaust manifold and end of tailpipe. Check and document (with photos) <i>If there is damage or leaks, the vehicle cannot be tested</i>	x		
<b>Exhaust gas relevant components</b> Check and document (with photos) all emissions relevant components for damage. <i>If there is damage, the vehicle cannot be tested</i>	x		
<b>Air filter and oil filter</b> Check for contamination and damage. Change if damaged or heavily contaminated or less than 800 km before the next recommended change.		x	
<b>Wheels (front &amp; rear)</b> Check whether the wheels are freely moveable or blocked or impeded by the brake. <i>If not freely moveable, the vehicle cannot be selected.</i>	x		Y
<b>Drive belts &amp; cooler cover</b> <i>In case of damage, the vehicle cannot be tested.</i>	x		
<b>Check fluid levels</b> Check the max. and min. levels (engine oil, cooling liquid) / top up if below minimum		x	
<b>Vacuum hoses and electrical wiring</b> Check all for integrity. <i>In case of damage, the vehicle cannot be tested.</i>	x		Y



<b>Injection valves / cabling</b> Check all cables and fuel lines. <i>In case of damage, the vehicle cannot be tested.</i>	x		Y
<b>Ignition cable (gasoline)</b> Check spark plugs, cables, etc. In case of damage, replace them.		x	
<b>EGR &amp; Catalyst, Particle Filter</b> Check all cables, wires and sensors. <i>In case of tampering or damage, the vehicle cannot be selected.</i>	x		
<b>Safety condition</b> Check tyres, vehicle's body, electrical and braking system status are in safe conditions for the test and respect road traffic rules. <i>If not, the vehicle cannot be selected.</i>	x		Y
<b>Semi-trailer</b> Are there electric cables for semi-trailer connection, where required?		x	Y
<b>Check if less than 800 km away from next scheduled service, if yes, then perform the service.</b>		x	Y
<b>Powertrain Control Module calibration part number and checksum</b>		x	Y
<b>OBD diagnosis (before or after the range test)</b> Read Diagnostic Trouble Codes & Print error log		x	
<b>OBD Service Mode 09 Query (before or after the range test)</b> Read Service Mode 09. Record the information.		x	
<b>OBD mode 7 (before or after the range test)</b> Read Service Mode 07. Record the information			

**Remarks for: Repair / replacement of components / part numbers**

## [Annex 2

### Monitor Flag

Cases where the monitor will raise a flag, since it will not be able to produce an accurate value or the vehicle has been used abnormally:

**Cases A: where the monitor does not have enough data to produce an accurate value:**

1. The vehicle has not done a full charge-discharge cycle during the last month

**Cases B: where the vehicle was used “abnormally”:**

1. The vehicle was stored (not connected) and not used for a full month on more than 3 occasions per year.
2. The vehicle was used more than 20 per cent of the time in conditions below -7 C or more than 35 C.
3. The vehicle was charged with superfast chargers more than 50 per cent of the time.
4. There was significant V2G or other usage of the battery that would not be shown by miles driven.

To be completed]

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