

GTR for in-vehicle battery durability

Main elements

This UN GTR applies to pure electric and OVC-HEVs vehicles of categories 1-2 and 2, both having a technically permissible maximum laden mass not exceeding 3,500 kg, and to all vehicles of category 1-P

State-of-Health (SOH)

The OEM shall install a SOH monitor that accurately reflects the deterioration of the battery. The SOH monitor shall be of inadequate granularity/accuracy (tbd) for the verifications to be made. The SOH monitor shall monitor both the capacity and range deterioration. For the purposes of consumer information, the OEM may display the capacity or both monitors at the vehicle dashboard.

The OEM shall ensure that the values (both capacity and range) of the SOH monitor (and all other pertinent values tbd) shall be made available both via the OBD port and over-the-air (OTA) while the battery is inside the vehicle. What about second life of batteries?

Performance Requirements

The CPs shall define Minimum Performance Requirements (MPR_i) for both capacity and range for batteries installed inside a vehicle (light-duty and at second phase heavy-duty). All batteries installed in OVC-HEVs and PEVs shall meet the Minimum Performance Requirements. The MPRs may differ depending on the type of vehicle and propulsion.

OEMs may declare better performance than the MPR_i, i.e. a Declared Performance Requirement (DPR_i). The OEM shall ensure that batteries installed in vehicles will perform equal or better than the MPR_i (or DPR_i) throughout the lifetime of the vehicle.

Phase 1: the MPR_i and DPR_i shall have a single value for year x, and km y.

Phase 2: the MPR_i and DPR_i could be defined with higher granularity with a different value per year and mileage.

Families Definition

Families]DP(1] with same characteristics for what regards batteries shall be defined as......

[Draft text]]EP2]

Only vehicles 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) Battery management system (BMS) specifically referring to the cooling system and the capacity reserve

(d) Worst case energy efficiency of the vehicle (if different); Insulation/packaging of the battery should be the same

[...]

(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 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;

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

(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

[...]

PART A of Verification: Verification of SOH monitor

The range/capacity shall be tested according to the original method used to define it in the legislation. The measured values, divided by the originally defined (or declared) range/capacity is defined as the “measured SOH_i” where i stands for range or capacity. ~~and~~ The measured SOH_i shall remain within z% (tbd) of the value r_{DP(3)} lead by the SOH monitor for capacity and range.

Vehicles shall be selected for testing after a survey (see annex 1) containing information designed to ensure that the vehicle has been used and maintained according to good practice.

3 to 10 vehicles shall be tested and the following statistics shall be used to take a decision on the accuracy of the monitor.

Statistics:

A vehicle test shall be considered a fail when the measured SOH is larger or smaller the SOH monitor $\pm z\%$.

A vehicle test shall be considered a pass when the measured SOH is within $\pm z\%$ of the SOH monitor value.

Pass/Fail decision for a sample

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

Upon the incorporation of valid SOH test results to an open instance of the statistical procedure, the type approval authority shall perform the following actions:

- update the cumulative sample size 'n' for that instance to reflect the total number of valid tests incorporated to the statistical procedure;
- following an evaluation of the results, update the count of passed results 'p' and the count of failed results 'f';
- 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 an **ISC-verification** sample the 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 **combination-of** vehicle family:

'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'.

'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.

Figure 1:

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

failed result count	10								FAIL
	9						FAIL	FAIL	

8						FAIL	FAIL	FAIL
7				FAIL	FAIL	FAIL	FAIL	FAIL
6			FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
5		FAIL	FAIL	FAIL	UND	UND	PASS	PASS
4	FAIL	FAIL	UND	UND	UND	UND	PASS	PASS
3	FAIL	FAIL	UND	UND	UND	UND	PASS	PASS
2	UND	UND	UND	UND	PASS	PASS	PASS	PASS
1	UND	PASS	PASS	PASS	PASS	PASS	PASS	PASS
0	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
	3	4	5	6	7	8	9	10

Cumulative sample size n

Corrective measures for the SOH monitor:

A fail decision shall lead to the requirement that the OEM fixes the faulty SOH monitor.

A pass decision allows for passing to Part B with the verification of the Fleet SOH.

PART B of Verification: Verification of Fleet SOH

Data shall be collected yearly by the authorities from all available statistically adequate sample of [DP(4)] vehicles within the family. The decision on the number of the vehicles in the sample may be taken by the authority based on risk assessment methodology, but can never be less than y (tbd). If the number of vehicles in the sample is less than x (tbd), then the vehicle survey in Annex 1 shall be used to decide whether the vehicle should be excluded from the sample or not. The data read shall be those of the SOH for both capacity and range (and other relevant data).

The average [DP(5)] of the SOH data for both capacity and range read from all available vehicles shall be defined as the Fleet SOH_i and shall remain yearly above the MPR_i (or DPR_i).

Corrective Measures for the Fleet SOH

If the Fleet SOH_i is below the MPR_i or DPR_i the verification of the Fleet SOH has failed and therefore corrective measures shall be taken on those vehicles with SOH which is less than the MPR (or DPR) with the agreement of the approval authority.

If the Fleet SOH_i is above the MPR_i or DPR_i the verification of the Fleet SOH has resulted in a pass.

Annex 1: Vehicle Survey

	x = Exclusion Criteria	X = Checked and reported	Confidential
Date:			X
Name of investigator:			X
Location of test:			X
Country of registration:		X	

Vehicle Characteristics	x = Exclusion Criteria	X = Checked and reported	Confidential
Registration plate number:		X	X
Mileage: <i>The vehicle must have mileage below the one defined <u>in this the relevant regional</u> regulation</i>	X		
Date of first registration:		X	

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

Name of the owner (only available to the accredited inspection body or laboratory/technical service)			X
Contact (address/ telephone) (only available to the accredited inspection body or laboratory/technical service)			X

How many owners did the vehicle have?		X	
Did the odometer not work? <i>If yes, the vehicle cannot be selected.</i>	X		
Was the vehicle used for one of the following? As car used in show-rooms? As a taxi? As delivery vehicle? For racing / motor sports? As a rental car?		X X X X	
Has the vehicle carried heavy loads over the specifications of the manufacturer? <i>If yes, the vehicle cannot be selected.</i>	X		
Have there been major engine or vehicle repairs?		X	
Have there been unauthorised major engine or vehicle repairs? <i>If yes, the vehicle cannot be selected.</i>	X		
Was the propulsion battery changed? <i>If yes the vehicle cannot be selected.</i>	X		
Has there been a power increase/tuning? <i>If yes, the vehicle cannot be selected.</i>	X		
Was any part of the emissions after-treatment replaced? Were original parts used? <i>If original parts were not used, the vehicle cannot be selected.</i>	X	X	
Was any part of the emissions after-treatment system removed or disabled? <i>If yes, the vehicle cannot be selected</i>	X		
Were there any unauthorised devices installed (Urea killer, emulator, etc)? <i>If yes, the vehicle cannot be selected</i>	X		
Was the vehicle involved in a serious accident? Provide a list of damage and repairs done afterwards		X	

<p>Has the car been used with a fuel type not specified by the manufacturer (i.e. gasoline instead of diesel) in the past? Has the car been used with non-commercially available fuel (black market, or blended fuel?) <i>If yes, the vehicle cannot be selected.</i></p>	x		
<p>Where do you use your vehicle more often?</p> <p style="text-align: right;">% motorway</p> <p style="text-align: right;">% rural</p> <p style="text-align: right;">% urban</p>	- - - -	- x x x	- - - -
<p>Did you drive the vehicle in a non-CP for more than 10% of driving time? <i>If yes, the vehicle cannot be selected.</i></p>	x	.	.
<p>In which country was the vehicle refuelled during the last two times? <i>If the vehicle was refuelled the last two times outside a state applying the relevant Fuel Standards, the vehicle cannot be selected.</i></p>	x		
<p>Has a fuel additive, not approved by the manufacturer been used? <i>If yes then the vehicle cannot be selected.</i></p>	x }	[DP(6)]	
<p>Has the vehicle been maintained and used in accordance with the manufacturer's instructions? <i>If not, the vehicle cannot be selected.</i></p>	x		
<p>Full service and repair history including any re-works <i>If the full documentation cannot be provided, the vehicle cannot be selected.</i></p>	x		
<p>Battery related checks: (Indicating Normal)^[DP(7)] Use</p>			
<p>How often did you charge the vehicle when:</p> <p style="text-align: right;">%with battery almost at 0 charge</p> <p style="text-align: right;">%with battery half charged</p> <p style="text-align: right;">%with battery almost fully charged</p>	- - -	x x x	
<p>On average how often were fast or superfast chargers used in a month?</p>		x	
<p>Has the vehicle been used extensively in ambient temperatures higher than 35 C, or lower than -7C? What percentage of time was the vehicle used in the following ambient temperature ranges:</p> <p style="text-align: right;">Below -7C:</p> <p style="text-align: right;">Between -7C and 35C:</p> <p style="text-align: right;">More than 35C:</p>		x x x x	
<p>Have the vehicle been used extensively for V2G? What percentage of time was the vehicle used for V2G?</p>		x	
<p>Has the vehicle remained parked and not used for more than x months per year? How many months per year was the vehicle parked and not used?</p>		x	

Vehicle Examination and Maintenance

X= Exclusion
Criteria
F= Faulty
Vehicle

X=checked and
reported

1	Fuel tank level (full / empty) Is the fuel reserve light ON? <i>If yes, refuel before test.</i>		x
2	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?) <i>If yes, the vehicle cannot be selected</i>	x	
3	Is the SCR light on after engine-on? <i>If yes, the reagent should be filled, or the repair executed before the vehicle is used for testing.</i>	x	
4	Visual inspection exhaust system 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	
5	Exhaust gas relevant components Check and document (with photos) all emissions relevant components for damage. <i>If there is damage, the vehicle cannot be tested</i>	x	
7	Fuel sample Collect fuel sample from non-pressurised fuel tanks		x
8	Air filter and oil filter Check for contamination and damage. Change if damaged or heavily contaminated or less than 800 km before the next recommended change.		x
10	Wheels (front & rear) 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	
12	Drive belts & cooler cover <i>In case of damage, the vehicle cannot be tested.</i>	x	
13	Check fluid levels Check the max. and min. levels (engine oil, cooling liquid) / top up if below minimum		x

15	Vacuum hoses and electrical wiring Check all for integrity. <i>In case of damage, the vehicle cannot be tested.</i>	x	
16	Injection valves/ cabling Check all cables and fuel lines. <i>In case of damage, the vehicle cannot be tested.</i>	x	
17	Ignition cable (gasoline) Check spark plugs, cables, etc. In case of damage, replace them.		x
18	EGR & Catalyst, Particle Filter Check all cables, wires and sensors. <i>In case of tampering or damage, the vehicle cannot be selected.</i>	x	
19	Safety condition Check tyres, vehicle's body, electrical and braking system status are in safe conditions for the test and respect road traffic rules. <i>If not, the vehicle cannot be selected.</i>	x	
20	Semi-trailer Are there electric cables for semi-trailer connection, where required?		x
24	Aerodynamic modifications Verify no aftermarket aerodynamic modifications that cannot be removed before testing were made (roof boxes, load racking, spoilers, etc.) and no standard aerodynamics components are missing (front deflectors, diffusers, splitters, etc.). <i>The vehicle cannot be selected if it is not in stock aerodynamic configuration and cannot be returned to that configuration before testing. Document with photos.</i>	x	-
22	Check if less than 800 km away from next scheduled service, if yes, then perform the service.		x
23	All checks requiring OBD connections to be performed before and/or after the end of testing		
24	Powertrain Control Module calibration part number and checksum		x
25	OBD diagnosis (before or after the emissions test) Read Diagnostic Trouble Codes & Print error log		x
26	OBD Service Mode 09 Query (before or after the emissions test) Read Service Mode 09. Record the information.		x
27	OBD mode 7 (before or after the emissions test) Read Service Mode 07. Record the information		

	Etc..		
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<p>Remarks for: Repair / replacement of components / part numbers</p>
