Observations from the pilot tests
EVE IWG 73rd session

July 09th

-online-

Usable Battery Energy (UBE)

- In order to quantify UBE, the current and voltage data is crucial. Using on-board sensors are the most reliable and direct way to obtain the data.
- As shown in the demonstration, it is almost impossible to mount external measurement devices on customer vehicles in a non-invasive and safe way.
- Thus we propose to use the on-board sensors and signals during in-service verification on customer vehicles.
- The sensors shall be verified at BOL during TA via test rig or external measurement equipment with effort.
- To provide UBE&UBC to the driver is ultimately essential, thus it is OEMs goal to do the UBE&UBC as accurate as possible.

Required measurement accuracy

1.2. Measurement requirements

Measurement devices shall be of certified accuracy as shown in Table A3/1 traceable to an approved regional or international standard.

The items atmospheric pressure and room or ambient~~(or on road)~~ temperature shall be at least recorded as single measurement activity at start of the vehicle battery testing and after end of the vehicle battery testing in all the test procedures as described in paragraph 3. of this Annex.

[Table A3/1

Measurement items and required accuracy

Item	*Units*	*Accuracy*	*Remarks*
Electrical voltage	V	[±0.3 % FSD or ±1 % of reading]	Whichever is greater. Resolution [0.1 V.]
Electrical current	A	±0.3 % FSD or ±1 % of reading	Whichever is greater. Resolution 0.1 A.
Room/ambient temperature	K	[±1 °C, with a measurement frequency of at least 0.033 Hz]	
Time	s	± 10 ms; min. precision and resolution: 10 ms	

- Accuracy requirements come from GTR15 and GTR21, which are both valid **ONLY** for external measurement devices
- Sensors accuracy will not be as good as measurement devices
- A second table to define sensor accuracy is needed when on-board sensors are used
- Sensor accuracy will be verified at BOL
- 2% of the reading for sensor accuracy

Tolerance needed

- HDV battery durability UBE is measured from road-test with on-board sensors which is not comparable to a perfectly-controlled dynamometer environment
- UBE is sensitive to the testing procedures and boundary conditions(e.g. temperature, driver, speed, road slope)
- More flexibility is required in this early stage, therefore we need a bigger tolerance

Tolerance and pass/fail criteria for both part A and part B

- Part A:
  - Test procedure for monitor verification 1a, 1b & 2 still being defined
  - Consequence: no extensive data yet for 1a, 1b or 2 test procedure repeatability
    - ➔ A factor & tp, tf parameters values to be confirmed **after monitoring phase**

- Part B:
  - MPR & 10% tolerance of pass/fail criteria for the family to be confirmed through monitoring phase
  - Monitoring phase of 2 years (2025-2027?) ➔ too short to secure field data covering fully Euro 7 mileage and years MPRs criteria
  - Practical proposal: cooperation with JRC on simulations & correlation with early ageing field data to confirm achievable MPRs

$$x_i = SOCE_{read,i} - SOCE_{measured,i}$$

$$X_{tests} = \frac{(x_1 + x_2 + x_3 + \cdots + xN)}{N}$$

$$s = \sqrt{\frac{(x_1 - Xtests)2 + (x_2 - Xtests)2 + \ldots + (xN - Xtests)2}{N-1}}$$

a) Pass the family if $X_{tests} \leq A - (tP_{1,N} + tP_{2,N}) \cdot s$

b) Fail the family if $X_{tests} > A + (tF_{1,N} - tF_2) \cdot s$

c) Take another measurement if:

$A - (tP_{1,N} + tP_{2,N}) \cdot s < X_{tests} \leq A + (tF_{1,N} - tF_2) \cdot s$

Alternative Pass/Fail criteria for Part A

- It is understandable to use this statistical method, as it originates from LDV emission regulation Euro V and VI ((EU) 2017/1151 Appendix 1 Verification of conformity of production for Type 1 test—statistical method)
- However for HDV the already exiting statistical method for pass/fail decision of the family(E/ECE/TRANS/505/Rev.1/Add.48/Rev.7 Appendix 3 table5: ISO 8422/1991)
- To keep the homogeneity of the EU VII regulation for HDV, we need to keep the same statistical method
- **Pass/fail decision criteria for single vehicle** needs to be defined instead of the “average value” from the current method

Table 5

Pass and fail decision numbers of Appendix 3 sampling plan
Minimum sample size: 3

Cumulative number of engines tested (sample size)	*Pass decision number*	*Fail decision number*
3	—	3
4	0	4
5	0	4
6	1	5
7	1	5
8	2	6
9	2	6
10	3	7
11	3	7
12	4	8
13	4	8
14	5	9
15	5	9
16	6	10
17	6	10
18	7	11
19	8	9

Break-off criteria

- The 4s-stop criteria is challenging to meet for 1a and 1b tests
- Early stop is needed for safety reasons for 1b, in such a case discharging through auxiliary shall be allowed
- Parallel stop criteria are needed: eg customer SOC 0 or dashboard warning
- A different break-off criteria must be defined

Test Methods

Testing methods

Methods for Checking Battery Durability Monitor for HDV			
	HDV with no bidirectional charging system		**HDV with bidirectional charging system**
	Method 1a	**Method 1b**	**Method 2**
Description	Discharge by standard average speed with tolerances on test track And charge	Discharge by driving on the road with average speed with higher tolerances And charge	Virtual Round Trip Efficiency (VRTE) test Discharging and charging by a bidirectional power supply or charging station
Alternative Method	HDV Dyno testing with similar driving characteristics		

Table A3/2 Selection of the testing methods

Methods for Checking Battery Durability Monitor for HDV				
	Method 1a	**Method 1b**	**Method 2**	**Alternative Method**
HDV with no bidirectional charging system	Manufacturer option	Manufacturer option if CPs allow	NA	CP option
HDV with bidirectional charging system			Manufacturer option	
Description	Discharge by mainly standard average speed with tolerances on test track And charge	Discharge by driving on the public road And charge	Virtual Round Trip Efficiency (VRTE) test Discharging and charging by a bidirectional power supply or charging station	HDV Dyno testing with similar driving characteristics

OICA Comments

- OICA stands for technology openness, feasible framework conditions and thus fair competition
- For CP markets Europe and US, chassis-dyno tests are no part of any type approval or certification framework
- Experience is missing, so we would need some time to verify chassis-dyno conditions

Backup

Pilot Phase location and timing

- confirmed -

	CW25	CW26	CW27	Point of contact	Method	Confirmation	Vehicle	Participants
Volvo			Sweden, Hällered Proving Ground, ***1st July***	Elie Garcia, Elie.garcia@volvo.com	**1a**	**Yes**	N3 Truck, >16t Tractor	**EPA**, James Sanchez
Scania		Sweden, Södertällje, ***27.-28. June***		Rong Sun, Rong.sun@scania.com	**1a**	**Yes**	N3 Truck, >16t (Rigid/Tractor)	**JRC**, Elena Paffumi, Gian Luca
Daimler Truck	Germany, Stuttgart, ***19.-21. June***	Germany, Stuttgart, ***whole week***	Germany, Stuttgart ***whole week***	Axel Trentzsch, axel.trentzsch@daimlertruck.com	**1b**	**Yes**	CW25: M3 Citybus CW26-27: N3 Truck >16t Rigid	**JRC**, Elena Paffumi, Gian Luca **UTAC**, Jose Fernandes **TÜV Nord**, Manuel Hagemann (*Witnessing as technical service*)

SOCE verification by UBE$_{measured}$ in Part A & certification

- Based on the current text, SOCE correlation has to be verified based on UBE$_{measured}$
- For UBE$_{measured}$ we believe in possible alternatives which are displayed below
- OICA intends to verify the following items during the pilot phase of Method1a and 1b
  - ⇒The impact of loading rates on UBE and UBC
  - ⇒Justification of alternative proposals listed below, especially #4
  - ⇒Improvement of WD description for Method1a and 1b

#	***UBE$_{measured}$*** verification	comments	Resulting formular
1	Verify Current, Multiply with on-board Voltage to get ***UBE$_{measured}$***	Accuracy low, feasibility limited and external influences of voltage measurement too high	$x_i = SOCE_{read,i} - \frac{\int I_{external} dt * U_{monitored}}{UBE_{certified}} * 100$
2	Verify current and Voltage begin of life externally on pack level By that, sensors are being certified life-long (see also EU-VI PEMS)	On test rig level, accuracy of signal verification is very high and approved/well established	$x_{I,i} = I_{read} - I_{measured}$ $x_{U,j} = U_{read} - U_{measured}$
3	Verify current and Voltage in alignment with authorities	Depending on ech cps authority	No formular needed anymore
4	Verify ***UBE$_{measured}$*** by comparing charged energy from charger with on-board energy	Using the charge cycle to verify UBE ***UBE$_{discharged}$*** and ***UBE$_{charged}$*** may be subject to a maximum allowed deviation of e.g. 5% (comparing slides 3 & 4)	$x_i = SOCE_{read,i} - \frac{UBE_{charged}}{UBE_{certified}} * 100; UBE_{certified} = UBE_{charged,begin\ of\ life}$