Japan Comments for Battery Durability GTR EVE39

4.November.2020

Contents

1.SOH family

1) Proposal of SOH Family and IP Family
2) New proposal including the vehicle selection for ISC Part A

2. SOH _ Capacity and SOH _ Range

3. Tolerance for ISC Part A (Capacity only)

1-1. SOH family definition

(1) Same algorithm for SOH calculation

(2) Same sensor specification (only sensors providing Input to the ECU for SOH calculation)
Voltage sensor: specs example., measured range (0 - 300 V**), Current sensor;** specs example**.,** measured range(0 - 200 A),
Accuracy ( ), guaranteed temperature range ( ),…..

(3) Definition of SOH family equivalence;
SOH_capacity_ecu = UBE_now / UBE_certification
UBE_now = F (Voltage, Current,,,,,)
If these two concepts remain the same in SOH calculations, the SOH family can be considered to be equivalent even if the algorithm (OEM Responsibility) is improved to the extent of the same algorithm.
The definition of "same algorism" needs to be considered.

1-2. IP family definition （Interpolation family） （quoted from GTR15）

5.6.3. Interpolation family for PEVs
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;
(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.
Two conditions are added to the GTR draft (Next Page), but (c) is included in (b) and (d) is a vehicle selection condition and not an IP family definition. It is recognized that the IP family was defined in GTR 15 including these battery requirements, and the necessity of adding these conditions is now unknown.

Families Definition (quoted from EVE38-15e)
Families with same characteristics for what regards batteries shall be defined as follows:
Draft text from GTR15
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

5.6.3. Interpolation family for PEVs (original GTR15 text)
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;
(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.

1-3.Family Usage for ISC Part A, Part B

ISC Part A **Judged by SOH Family**	ISC Part B **Judged by IP Family**	
within Criterion $(ECU\_SOH - Vali\_SOH)_{statics} \leqq Z$	$ECU\_SOH_{AVE} \geqq MPR$	$ECU\_SOH_{AVE} < MPR$
↓ PASS/FAIL	↓ PASS	↓ FAIL

[purpose]

1.To achieve a good balance between robust evaluation and test burden, by defining appropriate families to be tested .

2.Market measures based on ISC Part B to be effectively implemented avoiding unnecessary market disruption .

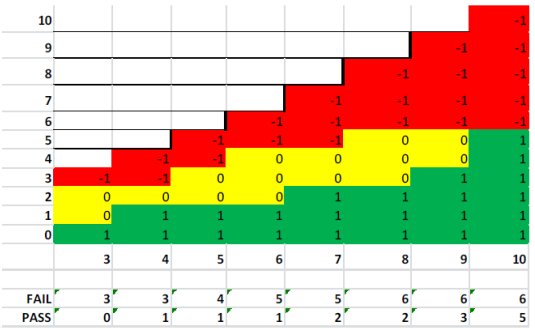
3.For ISC Part A, a wide range of vehicle selection based on the IP Family/mileage within the SOH Family can be possible (next page).

[proposal]

4.The verification of the SOH algorithm will continue even during ISC Part B. Part A is conducted every two years for each SOH Family as defined in figure on the right.

PART A: Sample Statistics

- *3- 10 vehicles tested for range/capacity*
- *Tested Range,Capacity/ Original Range,Capacity within x% of SOH*



Test cycle at ISC Part A	**WLTP**			**US**
	Level_1B	Level_1A	Level_2	
	3 phases	4 phases		FTP/HWFET/US06/SC03/Cold ?

1-４．ISC Part A Frequency of verifications

【GTR draft】

The manufacturer shall complete the procedure for in-use verification **at least every two years for the lifetime of each vehicle type** and report all values to the authorities. The authorities may decide to proceed with their own verification of either Part A, Part B or both at a frequency and magnitude based on risk assessment.

【Proposal】

		PEV/OVC-HEV **IP family**														**minimum # of tests**	remarks
		A		B		C		D		E		F		…			
age		~3 years	3 ~ 5 years	~3 years	3 ~ 5 years	~3 years	3 ~ 5 years	~3 years	3 ~ 5 years	~3 years	3 ~ 5 years	~3 years	3 ~ 5 years	~3 years	3 ~ 5 years		
mileage (preferably)		10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K	10K ~ 50K	30K ~ 80K		
for each **SOH family**	case_1	4	4													**8**	
	case_2	3	3	3	3											**12**	
	case_3	2	2	2	2	2	2									**12**	
	case_4	2*	2*	2*	2*	1	1	1	1							**12**	* : preferably higher sales volume
	case_5	2*	2*	1	1	1	1	1	1	1	1					**12**	
	case_6	1	1	1	1	1	1	1	1	1	1	1	1			**12**	
	case_7	1	1	1	1	1	1	1	1	0**	0**	1	1	1	1	**12**	** : preferably smaller sales volume

Purpose: Verify a wider range of mileage (not mentioned in current draft).
With good balance between robust evaluation and test burden.

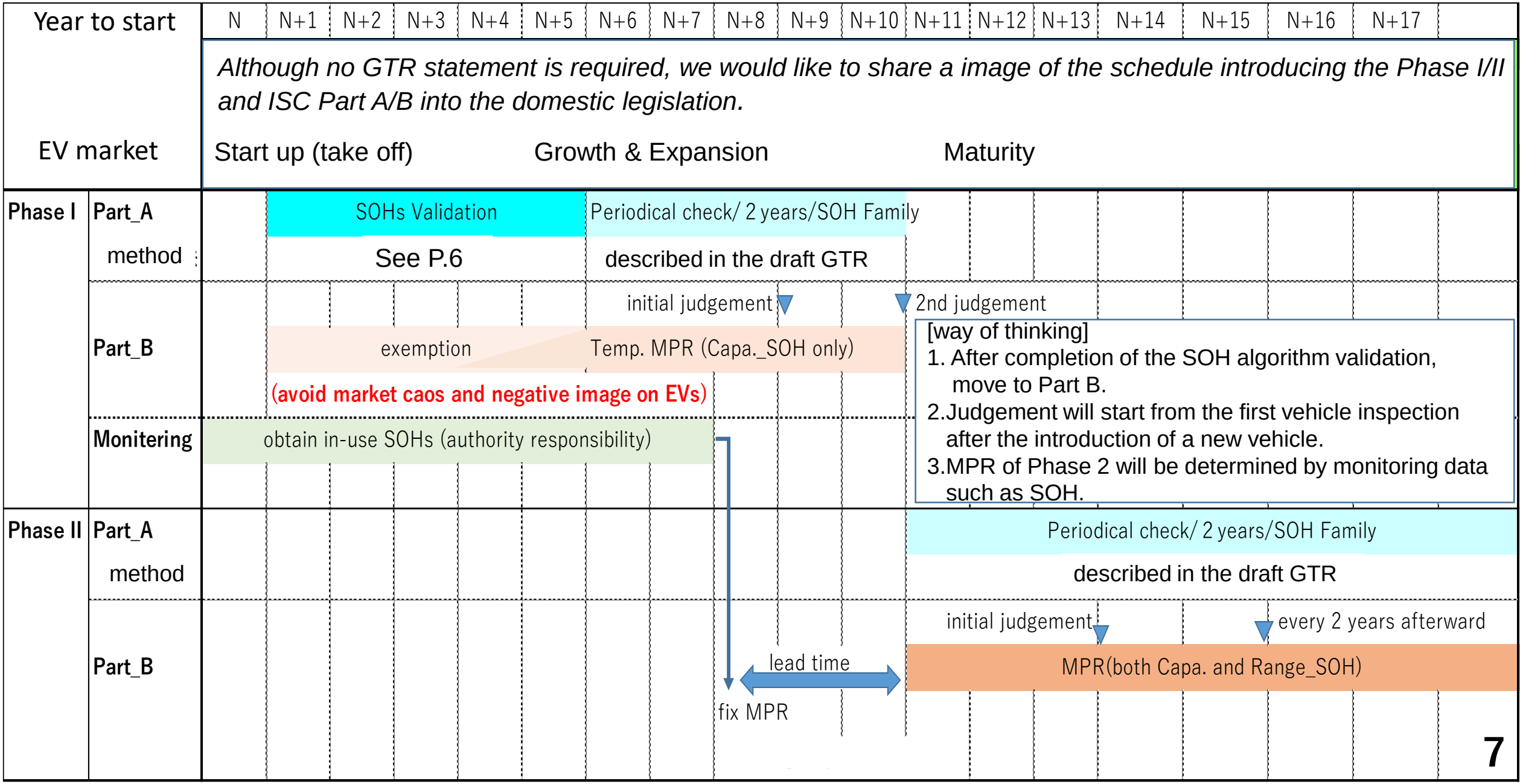
Judgement;

1. Compare the mean of all test results with tolerance Z.
2. When passing, it shifts to Part B. In case of failure,
   take measures as described in the draft GTR, and perform Part A again.

Case 1: GTR draft: at least 3 units every 2 years,
For 5 years, 7.5 units = > **8 units proposed**

Case 2 onward, for algorithm verification.
the ISC burden is reduced to select 1.5 times
= > **12 units proposed**

1-5.Phase I/II and ISC Part A/B Apply Schedule
(Example of application to automobile inspection system in Japan)



Japan can agree on the following directions discussed in the previous EVE.

1) In Phase 1, ISC Part A/B will be conducted only with SOH_Capacity and SOH_Range will only be monitored.

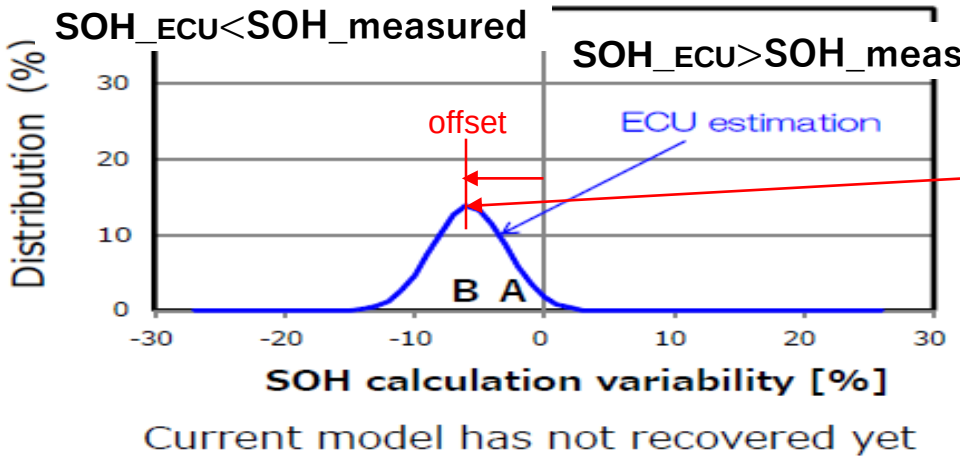
2) For the SOH Range in Phase 2,
MPR etc. will be determined based on the monitoring results in Phase 1.

3. Tolerance of ISC Part A (Capacity) :Z value

1) Preliminary value will be set in Phase 1 based on the possible data, such as investigated data in the market, provided by OEMs.
2) Tolerance for phase 2 will be revisited based on the data collected in Phase1.

ECU estimation accuracy of SOH

2012MY Prius PHV (previous Model)



Current model has not recovered yet

[%]	-99 Percentile	Average	+99 Percentile
Calculation error in in-vehicle ECU	-12.0	-5.3	1.4

Variation factor of capacity in ECU
1.Current and voltage sensors
2.Characteristic deviation of SOC-voltage relationship
3.Other, such as conservative estimation…

In the previous model, SOH in the in-vehicle ECU is lower than the measured true value by 5% on average and varies in a range of about 15%. Accumulating design tolerance further increases the variation.
Note; Vehicle A and B are within this variation.

From the above data , when defined ; $Z = SOH_{ECU} - SOH_{measured}$
Proposal 1) $-15\% < Z < +2\%$
2) $Z < +2\%$ (no tolerance on lower estimation side required))
$Z < +7\%$ (considered the distribution width remains the same and the offset will be improved)

- Comment on the text of the draft GTR –

SOCC monitor value for the consumer Info

<Concern>

The current text of the draft GTR regarding the value of the SOCC monitor for consumer info seems to be unclear on which systems or tools can be used.

(Current drat text)

For the purposes of consumer information, the OEM shall make easily available to the owner of the vehicle the most recently determined value of the SOCC monitor.

<Proposal to modify the current draft text >

For the purposes of consumer information, the OEM shall make easily available to the owner of the vehicle the most recently determined value of the SOCC monitor <u>via, but not limited to, the followings:.</u>

(i) <u>dashboard indicator</u>

(ii) <u>infotainment system</u>

(iii) <u>remote access (Utilization of mobile-phone applications).</u>