Japan's Proposal for GTR 21 revision

prepared by Japan

@EVE60

24th & 27th March 2023

Summary of JAPAN Proposal

No.	Item	Current text	Latest draft text（'23/1 Drafting）	JAPAN proposal
1	【5.2.1】 Measurement items and accuracy	Fuel flow rate ± 3 %	←	・The fuel flow rate can be replaced with the on-board measurement data because it can satisfy the accuracy requirements described in 5.2.1. ・For intake manifold pressure, we are considering accuracy guarantee when replacing on-board data. It will be reported in the next EVE.
		Intake manifold pressure ± 50 Pa	←	
	【6.1.2】 Required measurements	As an alternative to use of measurement devices, use of on-board measurement data is permissible if the accuracy and frequency of these data is demonstrated to the responsible authority to meet the minimum requirements for accuracy and frequency described in 5.2.	←	
2	【6.1.3.1】 Applicability of TP1	–	Current and voltage at the output of the REESS can be determined, and the distribution ratio (DR(1) and DR(2)), which represents the relative distribution of power to R1 and R2, respectively, can be accurately determined by reference to onboard torque command values.	When it is not possible to measure each motor power in a multi-motor system, since the accuracy has been proven, the motor torque of on-board measurement data can be used.
3	【7.2】 Family definition	–	※Excerpt (d) Type of battery cell, including format[, capacity, voltage,] and chemistry; [(e) Type of battery pack, including battery configuration (number of cells, mode of connection, etc.;] (f) Nominal voltage of the battery;	Since a battery can be defined as a pack if it has cells (d) and nominal voltage (f), it is proposed to delete the description of the battery pack (e).
4	【Annex3】 Determination of method equivalency	RESERVED: Determination of method equivalency	※Excerpt Upon request of the manufacturer, other measurement methods may be approved by the responsible authority if they yield equivalent results in accordance with paragraph 1.1. of this annex. The equivalence of the candidate method shall be demonstrated to the responsible authority.	should avoid the unique method which may loose regulatory fairness (JPN position is no change since UNR154)

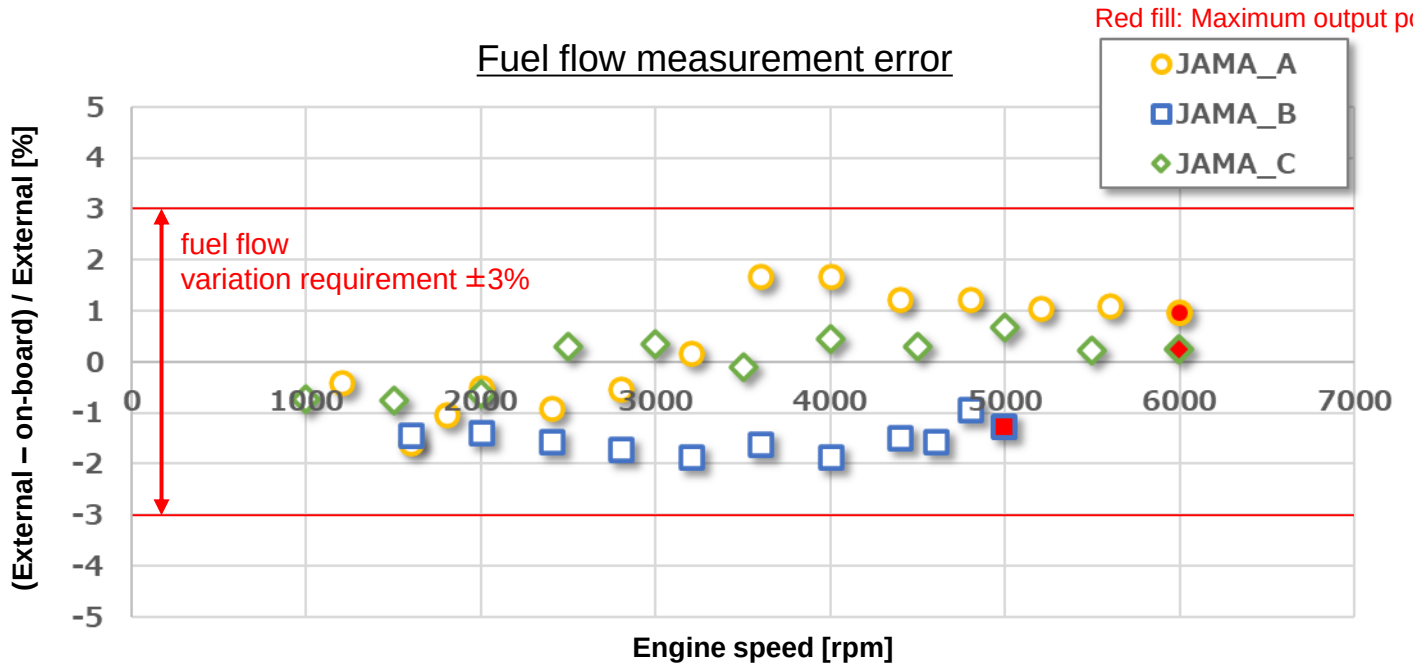
1. Proposal to replace fuel flow measurement with on-board data

■ Revision proposal summary

- Current requirement ： Measure using an external measurement devices, and the accuracy requirement is ±3%
- Reason for Proposal ： There is a safety risk of fuel leakage when measuring the fuel flow rate by modifying the in-vehicle fuel piping.
- Proposal content ： Since the on-board data of fuel flow rate satisfies the required accuracy of the external measurement device, it can be substituted.

■ Accuracy verification result

This is the result of JAMA3 companies, verifying the difference between the external measurement device and the on-board data.



<Test conditions>
- Engine: Turbo-charged
- Injector: Flow central product for approval
- Flowmeter: Certified product for approval

<Measurement point>
Stable flow rate with WOT for each rotation

- The result of JAMA3 companies confirm that the on-board data is within ±2% against the external measurement device.
- This accuracy is well within the ±3% tolerance of external measurement device and can be guaranteed even when replaced with on-board data.

The fuel flow rate can be replaced with the on-board measurement data because it can satisfy the accuracy requirement.

2. Proposal to utilize on-board data on motor torque

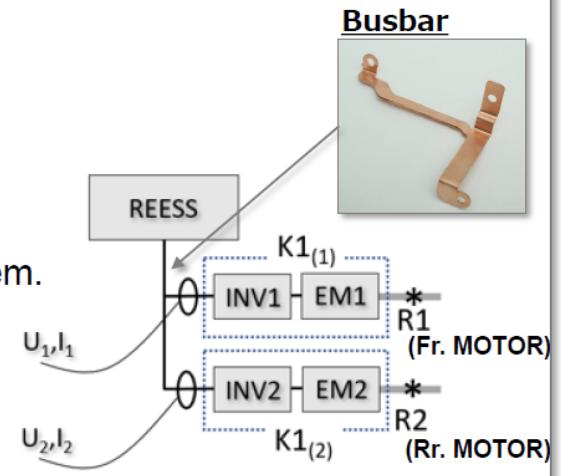
■ EVE#57 Japan Proposal Review

<sample> Problem and Solution

■ Scene Calculation of front and rear motor output in AWD system

■ Problem

- **Measurement** Busbar are used in integrated hybrid systems.
  Current/Voltage sensors are difficult to install in this type of system.
  Reason is lack of space and lack of electric safety.
- **Current text** Alternative method defined in 6.1.2. (demonstrate accuracy)
  doesn't work since no demonstration is feasible



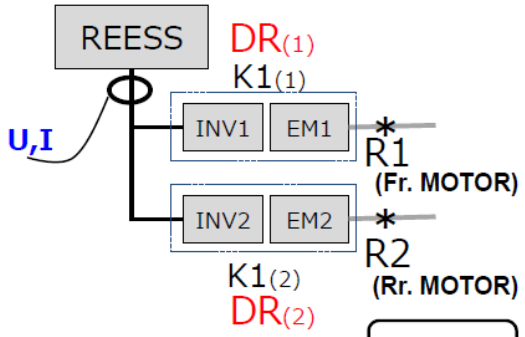
■ One of the possible solutions

Calculate R1/R2 branch power based on
(1) measured REESS power (**U, I**) before distribution and
(2) distribution ratio (**DR(1), DR(2)**) by torque command value from CAN

Power at R1 [kW] = (U [V] * I [A] / 1000) * K1(1) * DR(1)

Power at R2 [kW] = (U [V] * I [A] / 1000) * K2(1) * DR(2)

※Distribution Ratio (DR) : from CAN (%)



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Explained that since REESS power output is measured,
slight deviations in front/rear allocations will have few effect on system output.

Motor torque accuracy verification on-board data: ①Hybrid Vehicle

■ Investigation of the impact of power distribution deviation

＜Consideration conditions＞

- ・System： Electric four-wheel drive（Front/Rear 2motor）
- ・Engine power output： 130kW
- ・REESS power output： 35kW
- ・Motor inverter efficiency： 0.9～0.95@Maximum power point ※
- ・Distribution reference point： 50%
- ・Amount of distribution deviation： ±10%

＜Accuracy impact＞

System output deviation due to distribution value deviation（kW & %）

			Front efficiency	0.95	0.95	0.95	
			Rear efficiency	0.95	0.925	0.9	
Front distribution	(+10% deviation)	60		163.25	162.90	162.55	
	(+5% deviation)	55		163.25	162.86	162.46	
	(True)	50		163.25	162.81	162.38	
	(-5% deviation)	45		163.25	162.77	162.29	
	(-10% deviation)	40		163.25	162.73	162.20	(kW)
		(%)					

Front distribution	(+10% deviation)	60	0.00	0.05	0.11	
	(+5% deviation)	55	0.00	0.03	0.05	
	(True)	50	0.00	0.00	0.00	
	(-5% deviation)	45	0.00	-0.03	-0.05	
	(-10% deviation)	40	0.00	-0.05	-0.11	(%)

※ Motor inverter efficiency

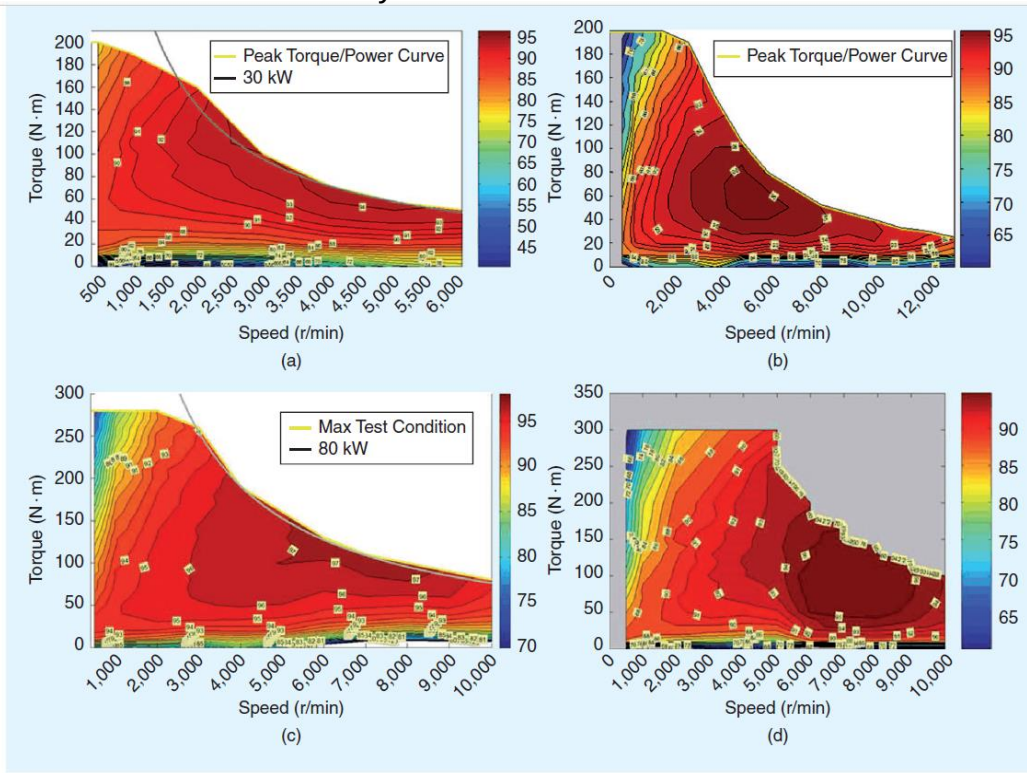

FIGURE 3. Efficiency maps of several IPM motors in EVs/HEVs [9], [12], [13]: (a) 2011 Sonata, (b) 2010 Prius, (c) 2012 Nissan Leaf, and (d) 2008 Lexus LS 600h.

[Source] january/february 2017 IEEE Industry Applications Magazine

System output calculation formula：

130＋[35×(Front distribution ratio)×(Front motor inverter efficiency] ＋ [35 ×(Rear distribution ratio)×(Rear motor inverter efficiency]

Even with the worst assumption, the impact on system output is ±0.11%, so the deviation in the distribution ratio does not need to be considered.
➡ Propose to utilize on-board data of motor torque in hybrid vehicle.

Motor torque accuracy verification on-board data: ②BEV

■ Investigation of the impact of power distribution deviation

＜Consideration conditions＞

- ・System： Electric four-wheel drive（Front/Rear 2motor）
- ・REESS power output： 35kW
- ・Motor inverter efficiency： 0.9～0.95@Maximum power point ※
- ・Distribution reference point： 50%
- ・Amount of distribution deviation： ±10%

※ Motor inverter efficiency

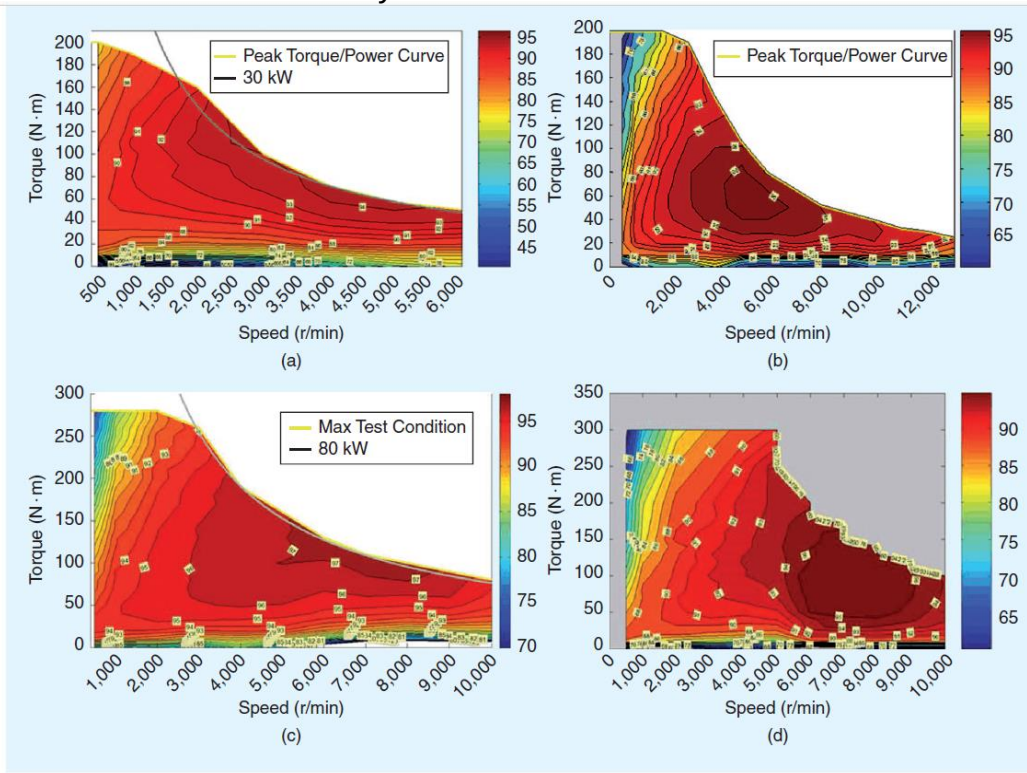

FIGURE 3. Efficiency maps of several IPM motors in EVs/HEVs [9], [12], [13]: (a) 2011 Sonata, (b) 2010 Prius, (c) 2012 Nissan Leaf, and (d) 2008 Lexus LS 600h.

[Source] january/february 2017 IEEE Industry Applications Magazine

＜Accuracy impact＞

System output deviation due to distribution value deviation（kW & %）

			Front efficiency	0.95	0.95	0.95	
			Rear efficiency	0.95	0.925	0.9	
Front distribution	(+10% deviation)	60		33.25	32.90	32.55	(kW)
	(+5% deviation)	55		33.25	32.86	32.46	
	(True)	50		33.25	32.81	32.38	
	(-5% deviation)	45		33.25	32.77	32.29	
	(-10% deviation)	40		33.25	32.73	32.20	
		(%)					

Front distribution	(+10% deviation)	60	0.00	0.27	0.54	(%)
	(+5% deviation)	55	0.00	0.13	0.27	
	(True)	50	0.00	0.00	0.00	
	(-5% deviation)	45	0.00	-0.13	-0.27	
	(-10% deviation)	40	0.00	-0.27	-0.54	

System output calculation formula：

[35×(Front distribution ratio)×(Front motor inverter efficiency] ＋ [35 ×(Rear distribution ratio)×(Rear motor inverter efficiency]

For BEV, even under the worst-case scenario, the impact is ±0.54%.
➡ Propose to utilize on-board data of motor torque in BEV.

3. JAPAN Comments on the family definition draft

■ Definitions of families（'23/1 Ver.）

7. Definitions of families

7.1. General

Vehicles having the same characteristics with respect to their evaluation for system power may be grouped into vehicle families for the purpose of determining a system power rating considered to be applicable to all vehicles in the family.

7.2. Family definition

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

(a) HEV system configuration[, including number, type, and mechanical arrangement of power sources; operating strategy; etc.];

(b) ICE power rating;

(c) Net power and construction type (asynchronous, synchronous, etc) of all electric machines in the HEV system, and type of electric energy converter between the electric machine(s) and the battery;

(d) Type of battery cell, including format[, capacity, voltage,] and chemistry;

[(e) Type of battery pack, including battery configuration (number of cells, mode of connection, etc.;]

Added from JAPAN proposal

(f) Nominal voltage of the battery;

(g) Maximum current of the battery; and

(h) Type of vehicle (PEV or OVC-HEV).

[At the request of the manufacturer, with the approval of the responsible authority and with appropriate technical justification, the manufacturer may deviate from the above criteria.]

■ Japan Proposal Family Definition @ EVE59

parameters			GTR#21 family definition proposal	
			①original (@EVE57)	②template terminology
【GTR#22】 Family definition	Type of vehicle (PEVs or OVC-HEVs)			H
	Type of electric machine	net power		C
		construction type (asynchronous/ synchronous, etc.)		C
	Type of battery	type of cell including format and chemistry		D,E
		nominal voltage		F
	Type of electric energy converter	Between the electric machine and battery		C
New Item	HEV System configuration		A	A
【UNR85】 Type approval	ICE power		B	B
	Motor power		C	
【UNR100】 Type approval	The cell chemistry		D	
	Configuration (number of cells, mode of connection, etc.):		E	
	Nominal voltage (V):		F	
	Maximum current (A):		G	G
Total			**7**	**9**

JAPAN proposal

JAPAN Comments

We propose to delete the added (e).
The reason is that by specifying single cell in (d) and nominal voltage in (f), they can be defined as the same family as a battery pack, so we believe that adding a new battery pack (e) is unnecessary.