交通安全環境研究所
National Traffic Safety and Environment Laboratory

Latest Progress on HD UBE Measurement

prepared by JAPAN

62nd EVE IWG

30th May, 2023

EVE-62-07e

Reprint

JPN introduced the Progress Status on HD UBE Measurement at 61st EVE IWG
(25th & 26th April, 2023)
↓
This file is the Latest Progress

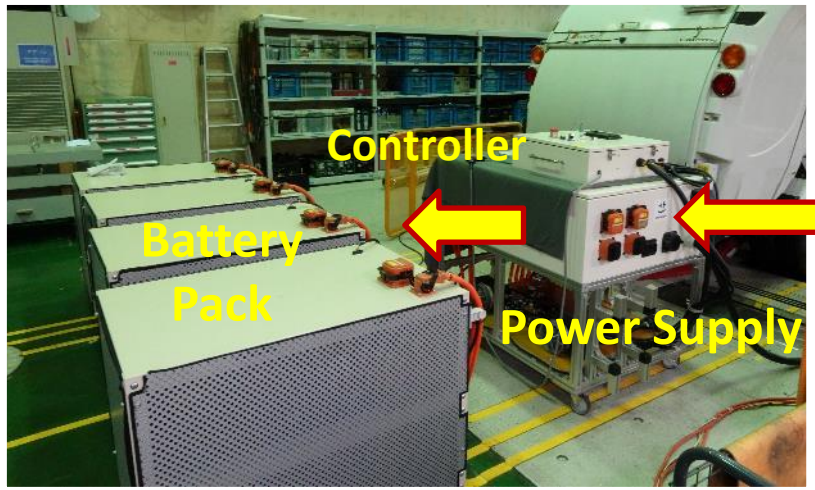
Approach

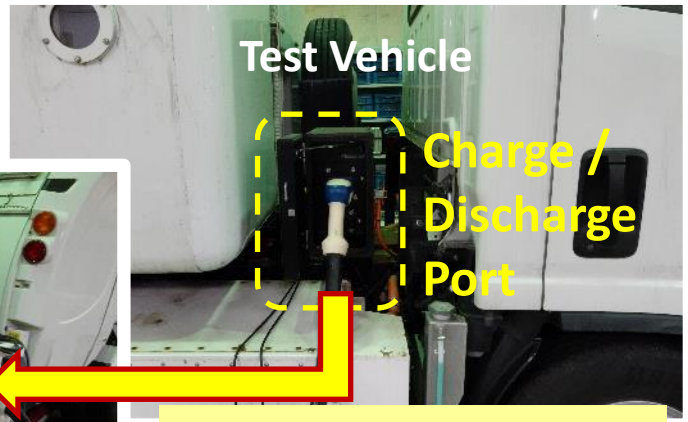
【Focus】
✓ JPN evaluates the gap (error) of its **battery discharged energies (UBE)** obtained under the two (2) different test procedures

① Chassis Dynamometer Test
② Charge / Discharge Test

① Chassis Dynamometer Test

② Charge / Discharge Test





By using V2X function

Power : One-way
(Vehicle → Power supply)

【Test Vehicle】
- EV Truck（GVW：7,500kg）
- Battery Capacity：48kWh (Lithium-ion Battery)
- Motor Power : 93kW (Rated Power)

【Test condition】
- Test Room Temperature：25℃ (Setup)

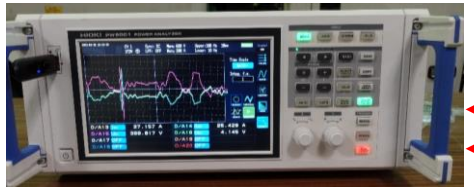
→ *Vehicle Battery Temperature (CAN Signal) at Soak :23 ℃*

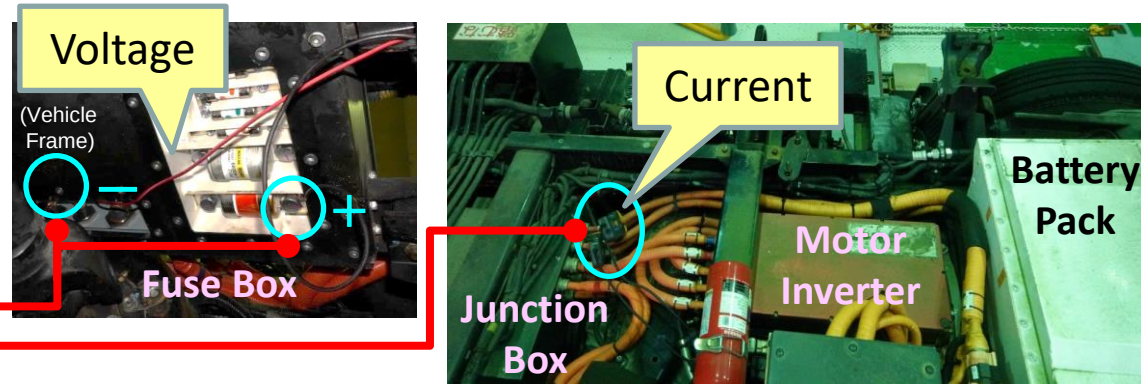
Measurement & Test Condition

【Sampling Point】

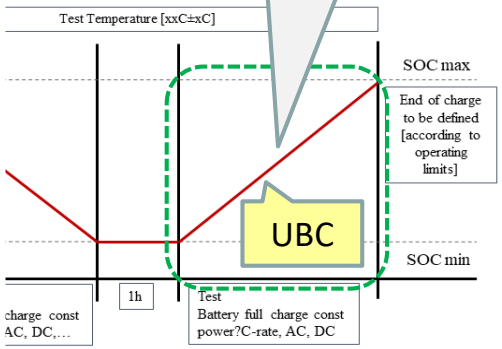
Current, Voltage

(PW6001 : HIOKI)





≪Reference≫
Charging (AC:200V)
1080 min. (18 hour)



【Data Sampling Frequency】

GTR No.15 Annex8 Appendix3 (please refer slide 10)

（Measurement Equipment）

- 20Hz → Current, Voltage
- 10Hz → Chassis Dynamometer Data

（CAN Signal）

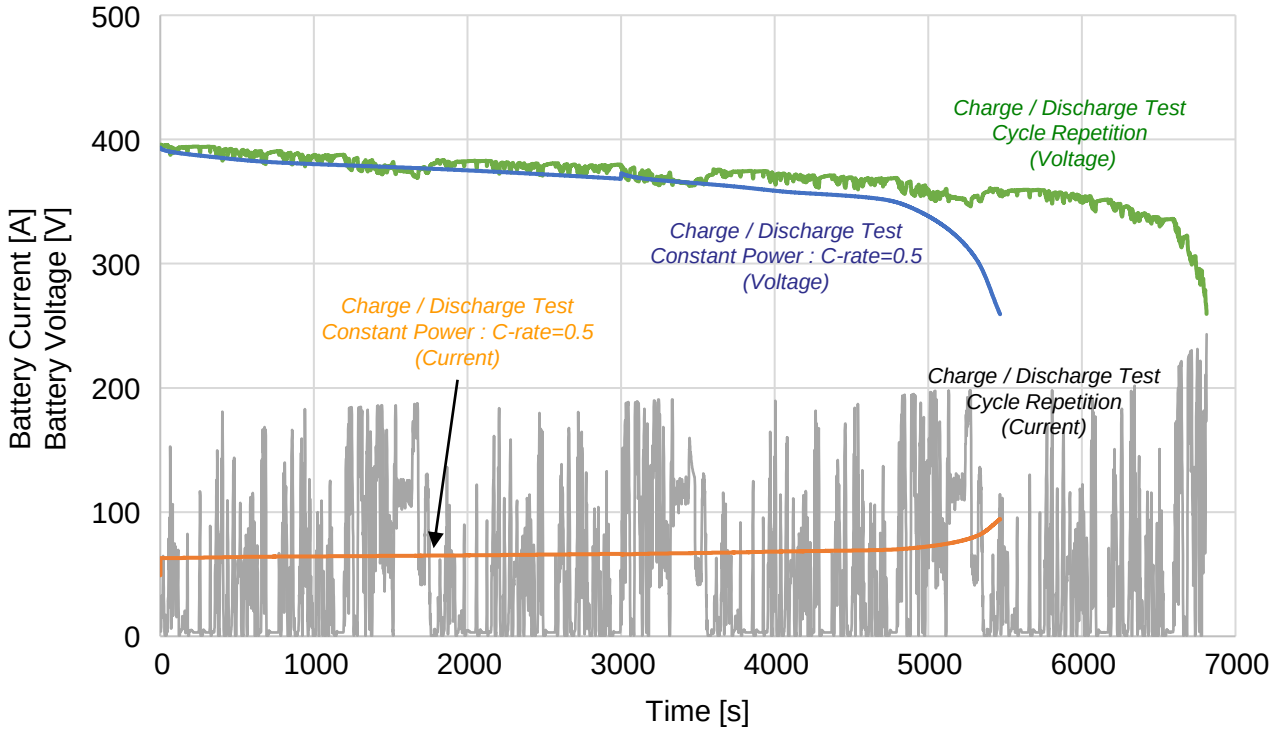
- 100Hz → Current, Voltage
- 10Hz → SOC
- 5Hz → Battery (Cell) Temperature

Data gap of this test ≦ 1%

【Calculate UBE】

$$\int (A \times V)\, dt$$

- A : Current [A]
- V : Voltage [V]



Test Procedure

Reprint

① Chassis Dynamometer Test (WHVC+Road Gradient) ←*GTR No.4_ Section 9 (Annex9, 10)*

(a) Obtain the discharge pattern data of the battery power from SOC max to SOC min (Cycle Repetition).

(b) Measure the total amount of battery discharged energy

② Charge / Discharge Test

→ Measure the total amount of the battery discharged energy of the following conditions

(1) Cycle Repetition : The discharge pattern simulating the chassis dynamometer test ①

(2) Constant Power : Power (10.3kW) ・・・C-rate=0.2

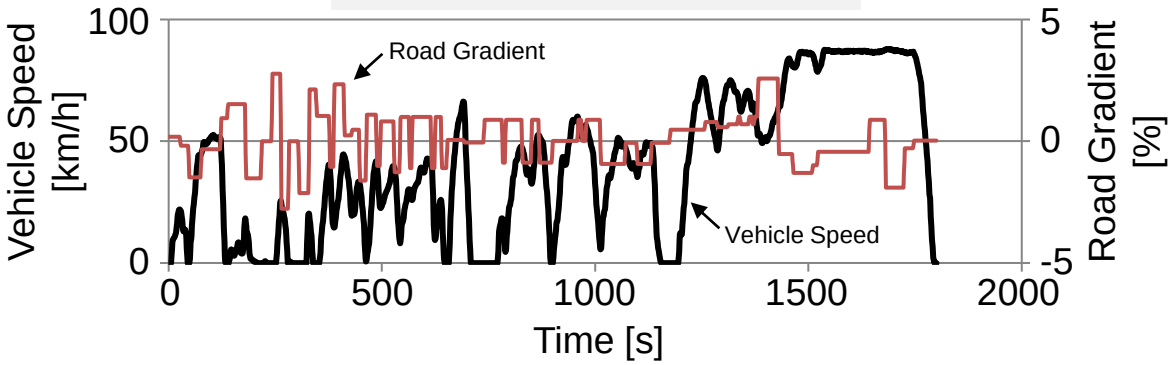
(3) Constant Power : Cycle Average Power (24.3kW) ・・・C-rate=0.5

(4) Constant Power : Power (48.0kW) ・・・C-rate=1.0

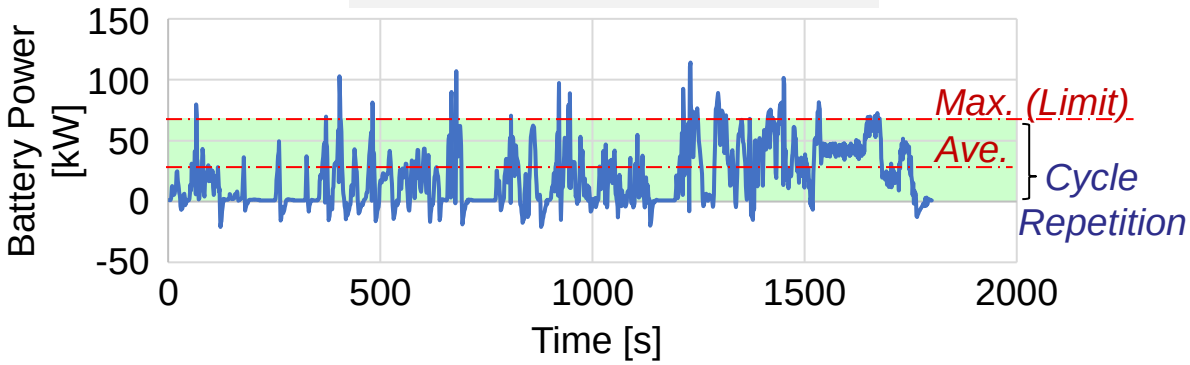
(5) Constant Power : Cycle Maximum Power (114kW) → V2X Power Limit (Max.=69kW) ・・・C-rate=1.4

$$\textbf{C-rate} = \frac{\text{Setup Power [kW]}}{\text{Battery Capacity(48kWh)}}$$

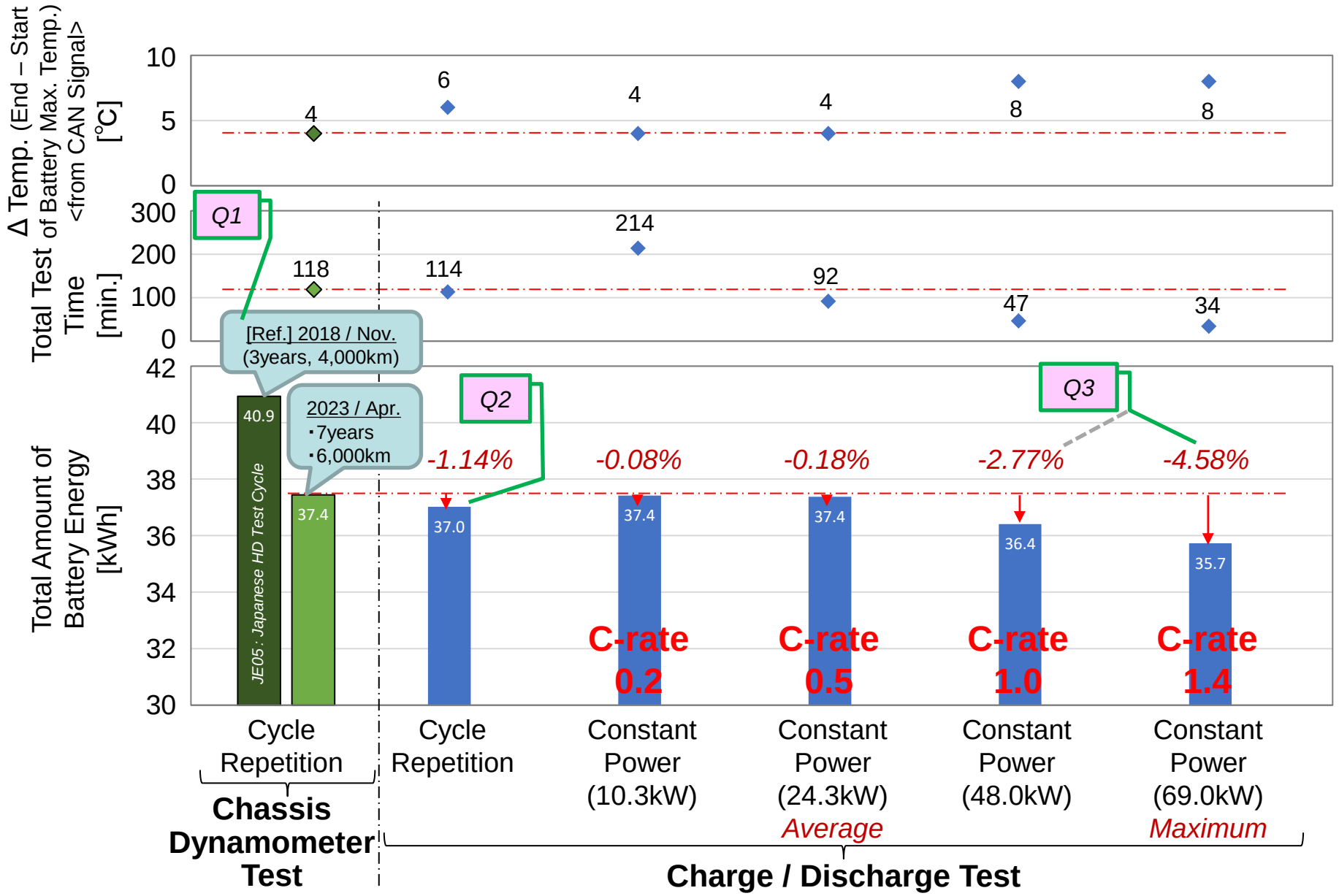
【Cycle Pattern】



【Battery Power】



Result



【Question → Answer】

Q1. The Initial performance data (UBE) of test vehicle. ・・・?

→ Add the data on this slide

Q2. The result of the cycle repetition by using the charge / discharge test has the gap (-1%) compared with that of the chassis dynamometer test. ・・・?

→under the investigation

Q3. The high C-rate test has the large gap. ・・・?

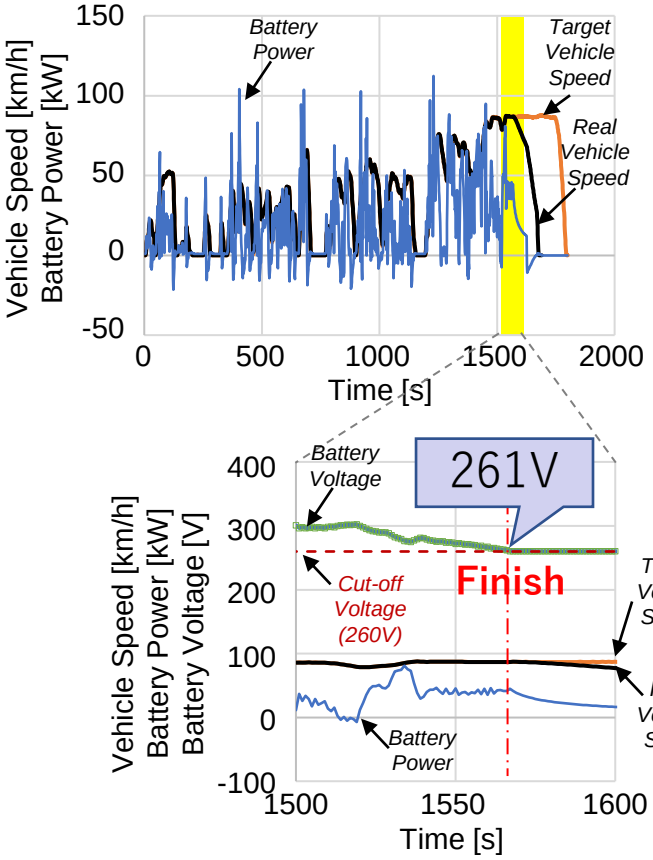
→refer next slide

Consideration : Constant Power

SOC=minimum → Cut-off Voltage = 260V

Chassis Dynamometer Test

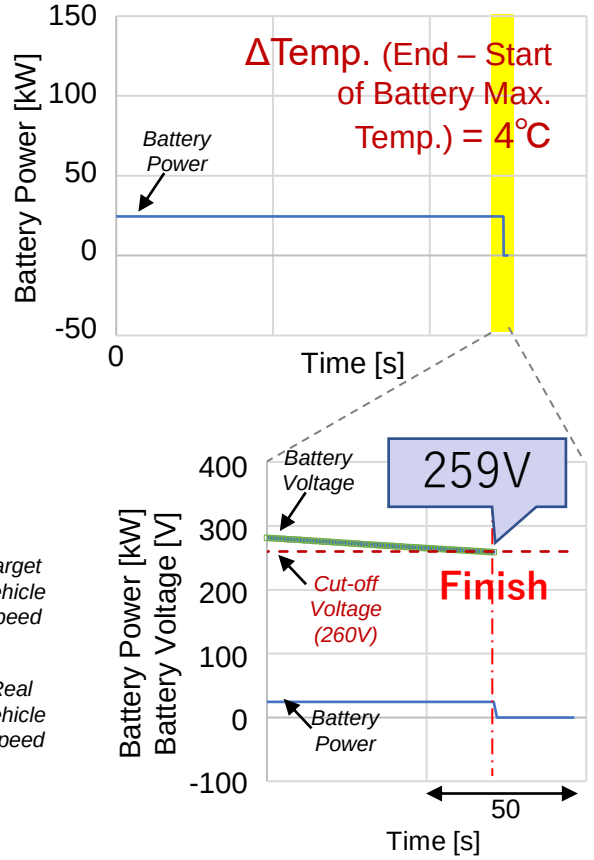
Cycle Repetition



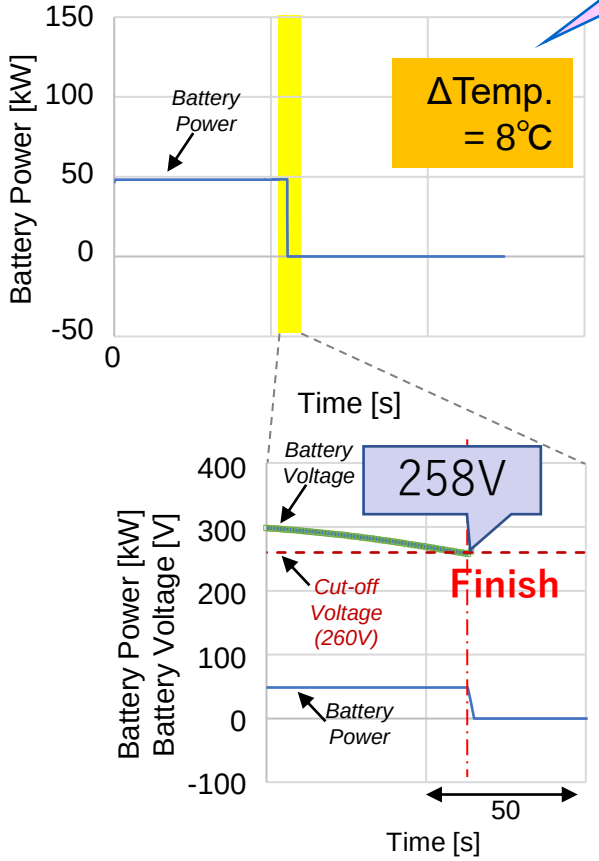
Charge / Discharge Test

【Gap】 ΔT=8℃
lead the battery internal resistance increased

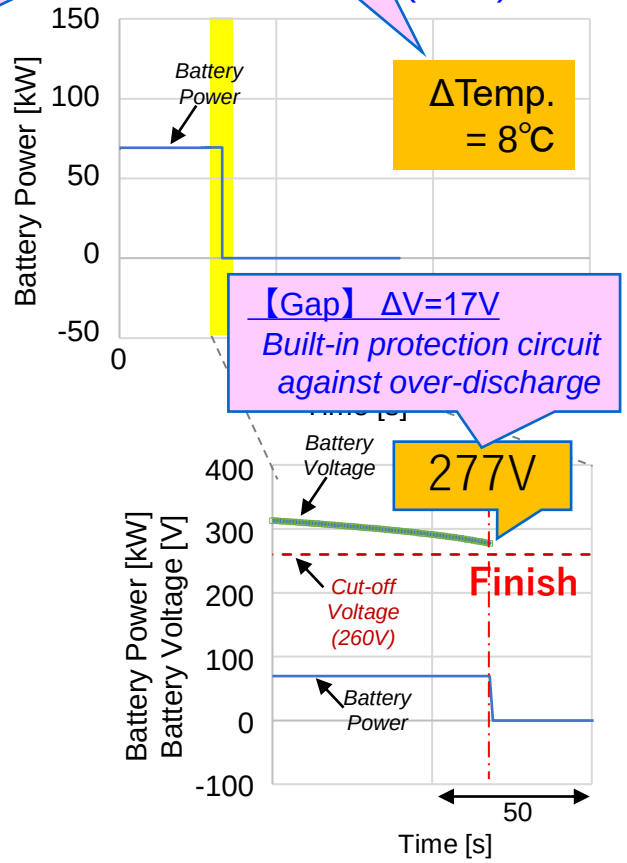
C-rate = 0.5 (Ave.)



C-rate = 1.0



C-rate = 1.4 (Max.)



<In case of the high C-rate>

The discharge is terminated before reaching the cut-off voltage (=260V) due to the protection logic against over-discharge. In addition, the higher delta battery (cell) temperature leads the battery internal resistance increased.

Conclusions

- Charge/Discharge test (e.g. bidirectional charger) can be one of the solutions to determine HDVs UBE when considering its complexity during in-service testing
  (same observation as last report)
- Charge/Discharge test result of this vehicle is shown below,
  - ✓ The constant output power discharge is recommended.
    (cycle repetition may have restriction per design configuration)
  - ✓ Appropriate C-rate range might exist per its own unique BMS

< Next Actions >

- Further analysis on a variety of collected data
- Propose concrete contents (i.e. current/voltage measurement technique, discharge pattern, C-rate range and others) to be incorporated into the GTR

Appendix

Background

Reprint

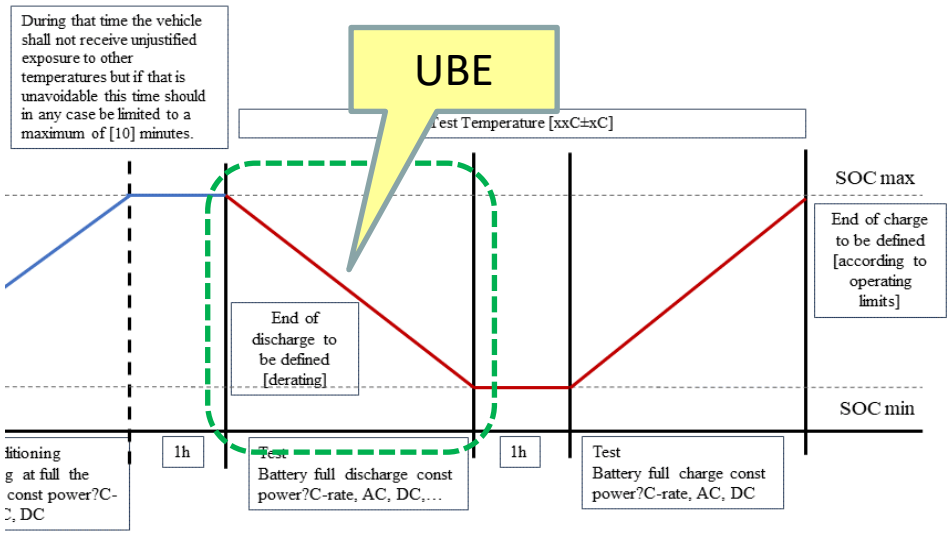
UBE test for Heavy-duty vehicles

【EVE-59】10/Jan./2023

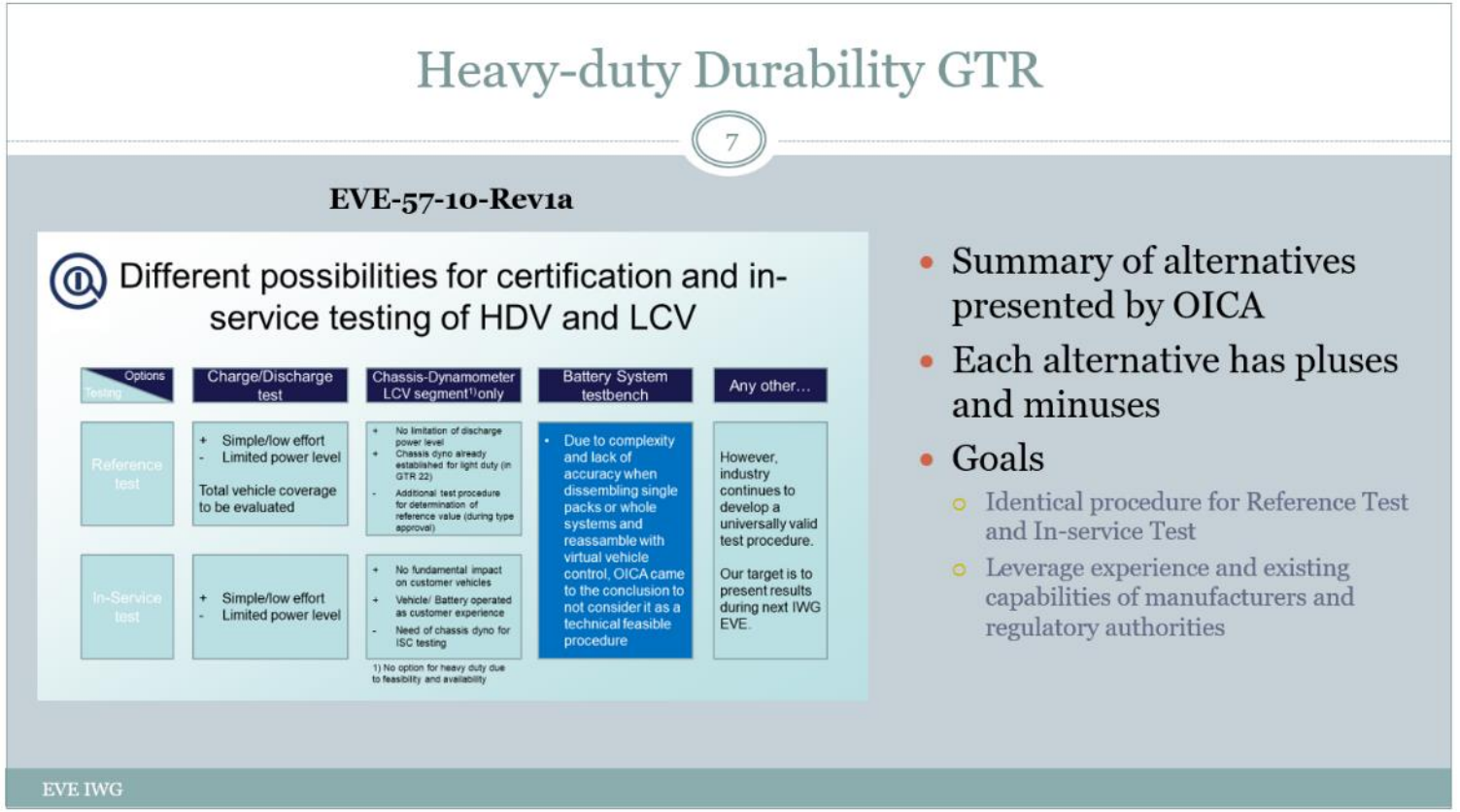
As a first step,

JRC execute the Charge / Discharge Test.

JPN also starts the physical tests to develop the test procedure for UBE determination < April/2023 ～ >



Informal document **GRPE-87-52**
87tf GRPE, 10 January~13 January 2023
Agenda item 9



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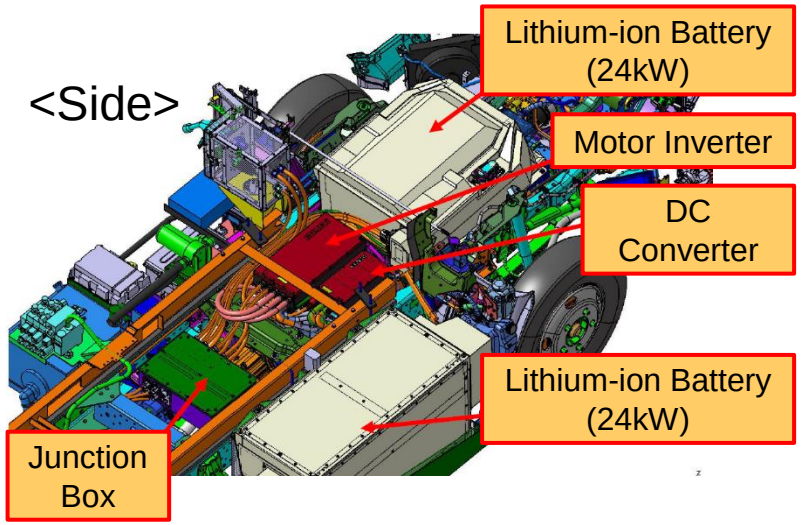
(25th & 26th April, 2023)

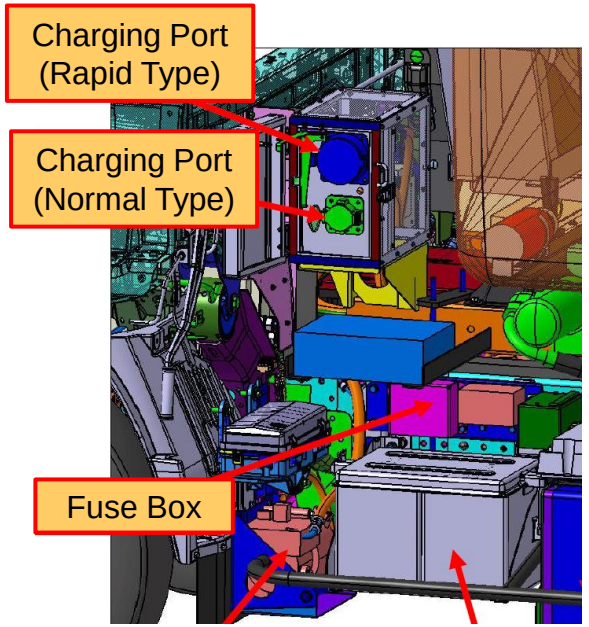
Equipment

【Test Vehicle】

<Front>

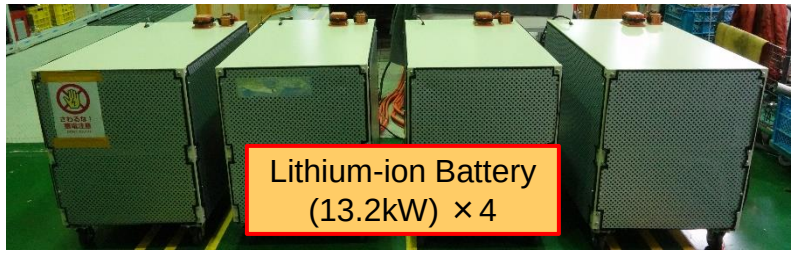
<Side>

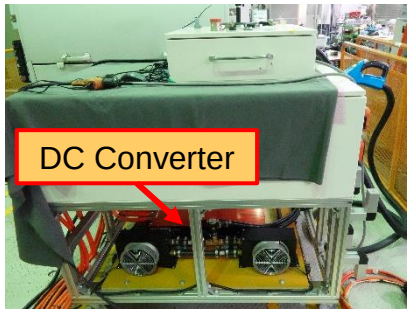




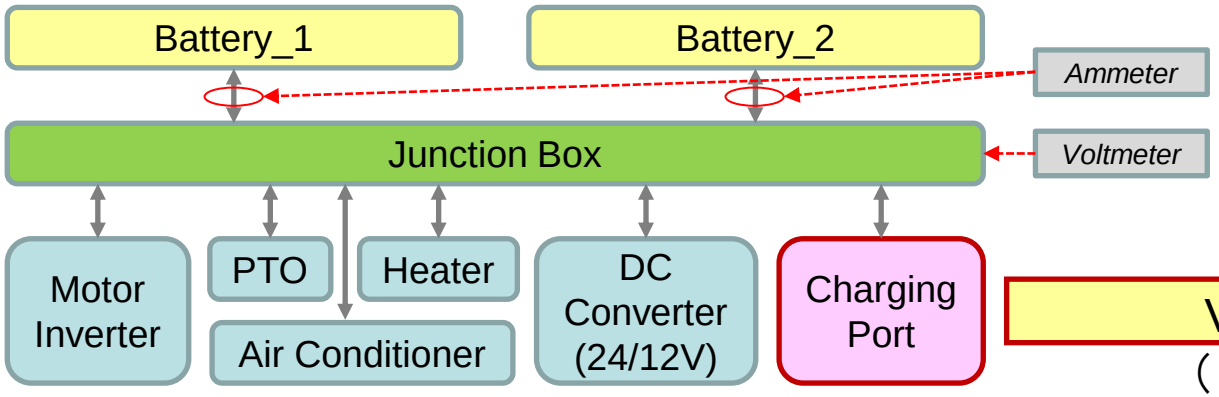
<Side>

【Charge / Discharge System】

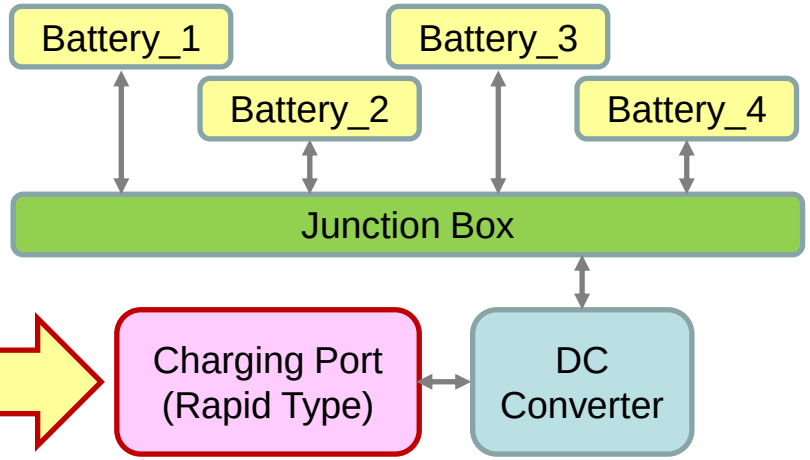




< Component Drawing >



V2X Function
（ Connection ）

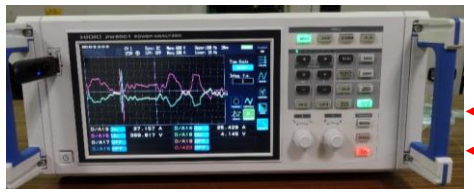


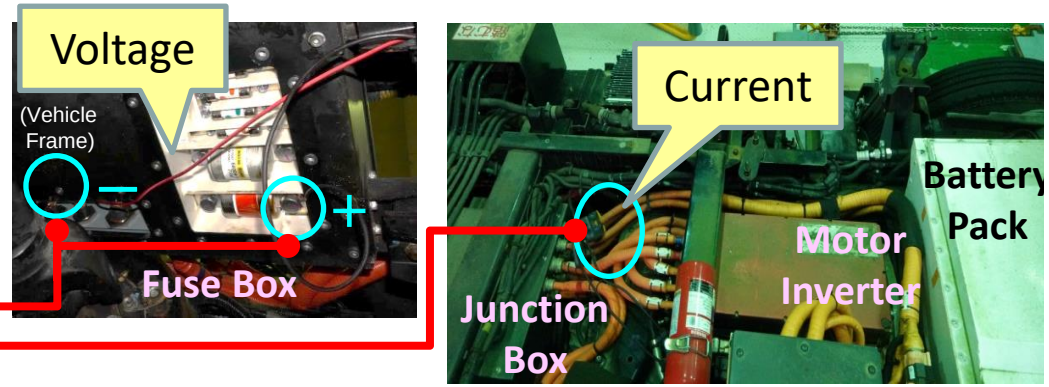
Measurement Condition

【Sampling Point】

Current, Voltage

(PW6001 : HIOKI)





GTR#15 Annex8/Appendix3

Table A8 App3/1

Test events	*Para. 3.1.*	*Para. 3.2.*		*Para. 3.3.*
		60V or more	*Less than 60V*	
NOVC-HEV	shall not to be used	shall be used		shall not to be used
OVC-HEV CS condition				
NOVC-FCHV				
OVC-FCHV CS condition				
REESS energy change-based correction procedure (Appendix 2)				
OVC-HEV CD condition	shall be used	shall not to be used	allowed to use	allowed to use
OVC-FCHV CD condition				
PEV				

【Data Sampling Frequency】

（Measurement Equipment)

- 20Hz → Current, Voltage
- 10Hz → Chassis Dynamometer Data

（CAN)

- 100Hz → Current, Voltage
- 10Hz → SOC
- 5Hz → Battery (Cell) Temperature

【Calculate UBE】

$$\int (A \times V)\, dt$$

- A : Current [A]
- V : Voltage [V]

3. REESS voltage

During the tests described in paragraph 3. (this paragraph) and in Appendix 2 of this annex, the voltage shall be determined by the following options and applicable test event of each option is defined in Table A8.App3/1.

3.1. Externally measured REESS voltage

The REESS voltage shall be measured with the equipment and accuracy requirements specified in paragraph 1.1. of this annex. To measure the REESS voltage using external measuring equipment, the manufacturers shall support the responsible authority by providing REESS voltage measurement points and safety instructions.

3.2. Nominal REESS voltage

The nominal voltage of the REESS determined according to IEC 60050-482.

3.3. Vehicle on-board REESS voltage

As an alternative to paragraphs 3.1. and 3.2. of this appendix, the manufacturer may use the on-board voltage measurement data. The accuracy of these data shall be demonstrated to the responsible authority.

Test Condition

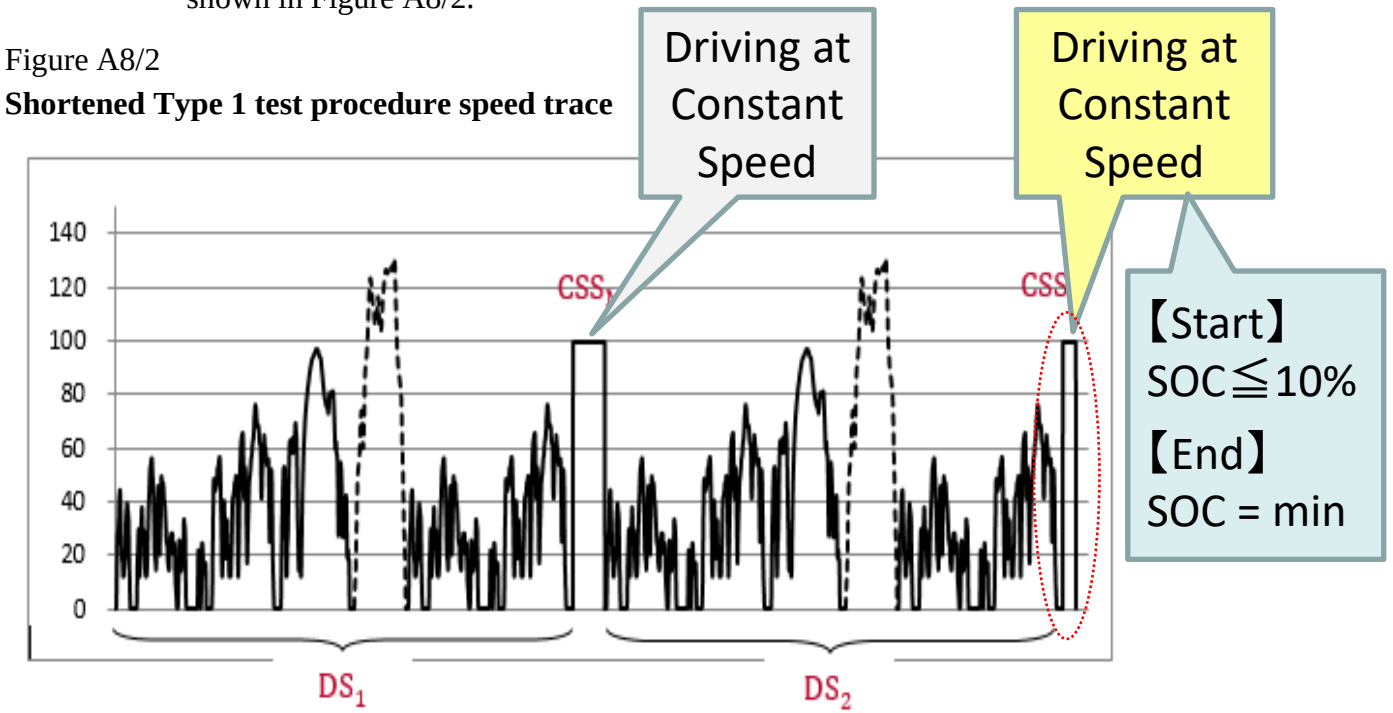
Proposal for Amendment 5 to UN GTR No. 15 (Worldwide harmonized Light vehicles Test Procedures (WLTP))

3.4.4.2. Shortened Type 1 test procedure

3.4.4.2.1. Speed trace

The shortened Type 1 test procedure consists of two dynamic segments (DS_1 and DS_2) combined with two constant speed segments (CSS_M and CSS_E) as shown in Figure A8/2.

Figure A8/2
Shortened Type 1 test procedure speed trace



3.4.4.2.1.2. Constant speed segment

The constant speeds during segments CSS_M and CSS_E shall be identical. If the interpolation method is applied, the same constant speed shall be applied within the interpolation family.

(a) Speed specification

The minimum speed of the constant speed segments shall be 100 km/h. If the extra high phase (Extra $High_3$) is excluded by a Contracting Party, the minimum speed of the constant speed segments shall be set to 80 km/h. At the request of manufacturer and with approval of the responsible authority, a higher constant speed in the constant speed segments may be selected.

(b) Distance determination of CSS_E and CSS_M

The length of the constant speed segment CSS_E shall be determined based on the percentage of the usable REESS energy UBE_{STP} according to paragraph 4.4.2.1. of this annex. The remaining energy in the traction REESS after dynamic speed segment DS_2 shall be equal to or less than 10 per cent of UBE_{STP}. The manufacturer shall provide evidence to the responsible authority after the test that this requirement is fulfilled.

Test Procedure：Battery Cell Temperature & Time

✓Test Room Temperature：25℃ (Setup)

✓The battery condition at the test start
↓ <*assumingly*>
Battery (Cell) max. temperature
≦ Room temperature (Setup) +5℃