

Test method by using HD chassis dynamometer

~Alternative method For UBE~

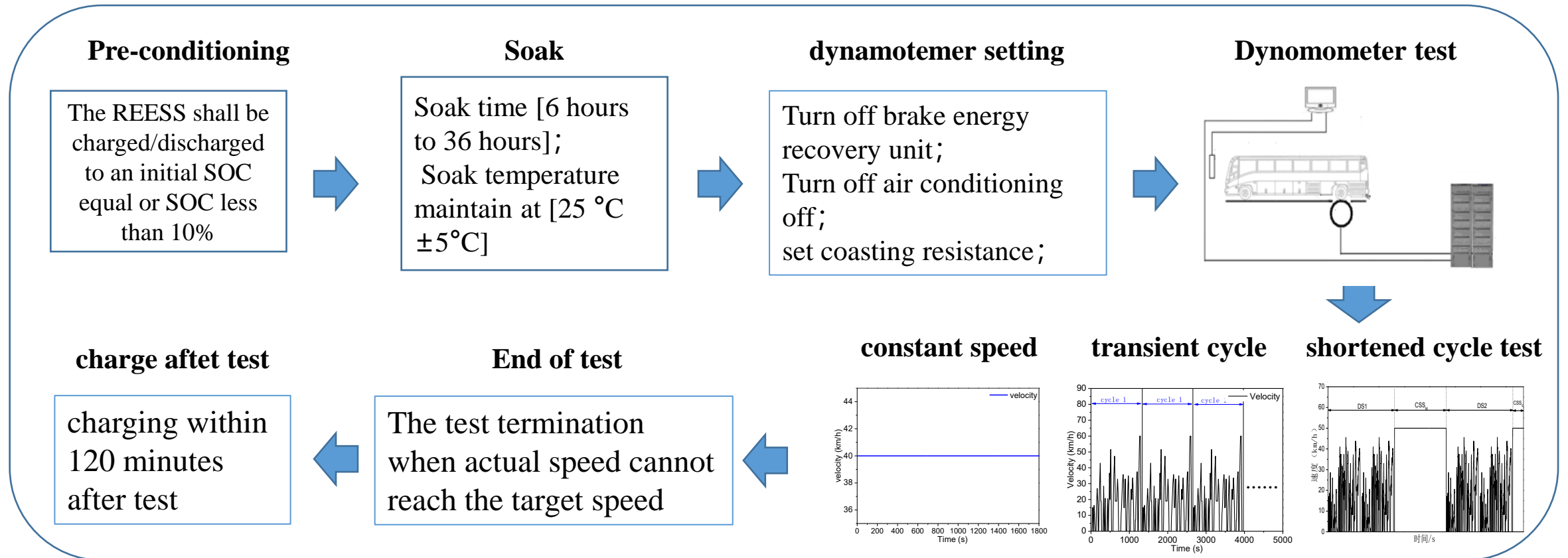
China, September, 2024

China Heavy-duty electric vehicle test methods (UBE)

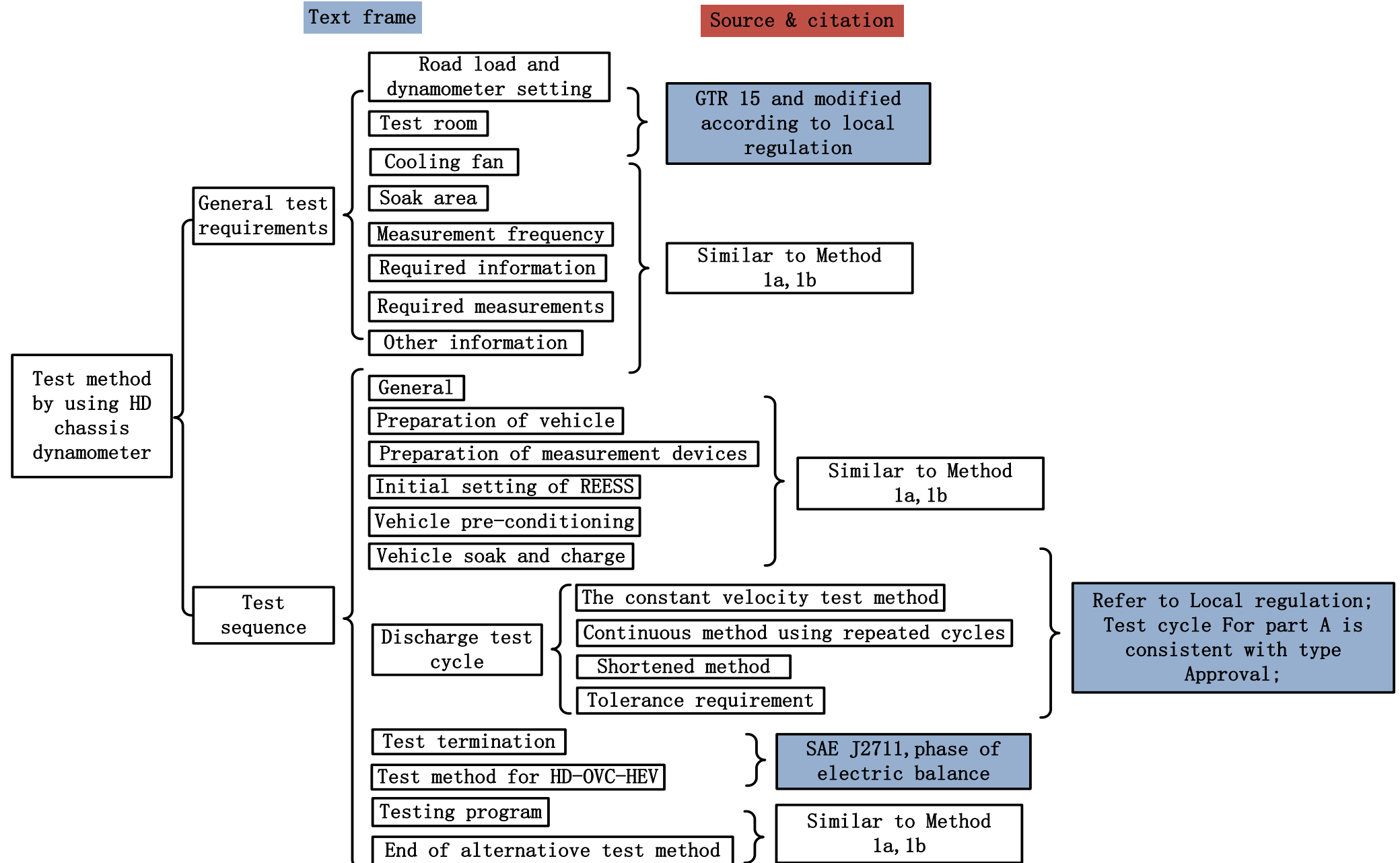
The measurement method of the on-board SOCE

China proposes to add cycle test method by using HD chassis dynamometer to measure UBE, which is used to calculate on-board SOCE, The test method is shown below.

UBE test flow chart



Text frame of alternative method



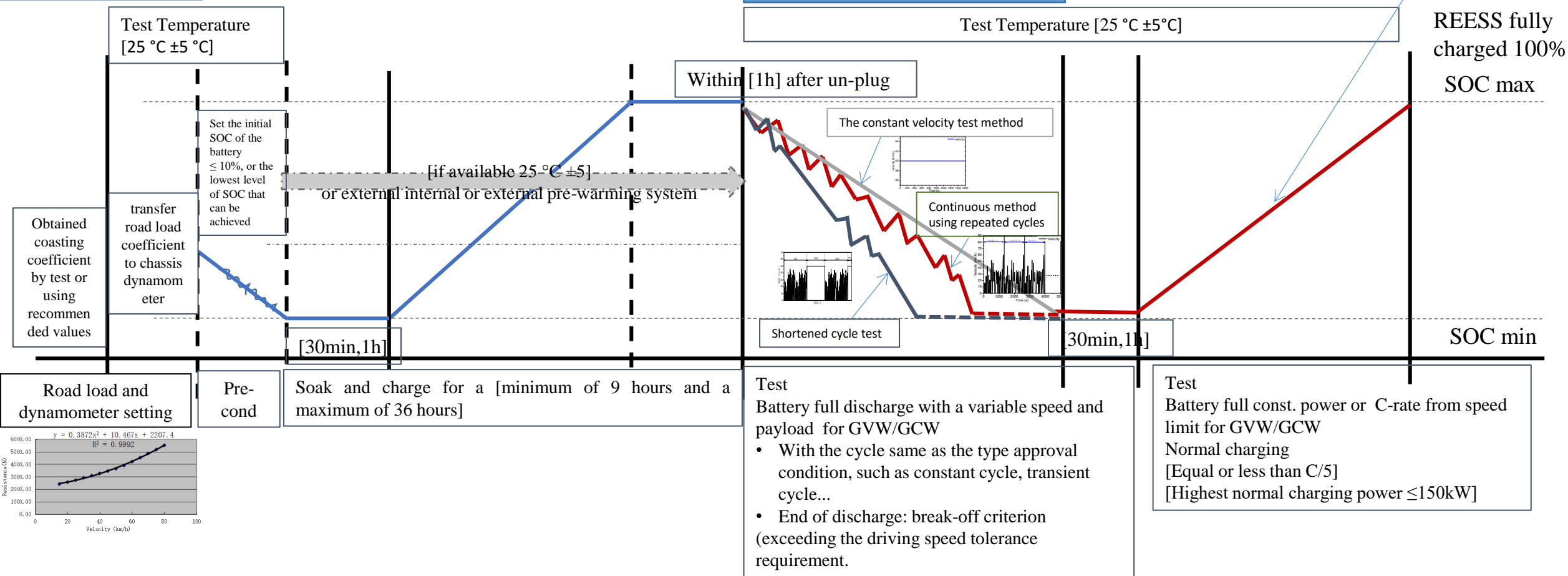
Alternative method using HD chassis dynamometer

- The test shall be carried out on **HD chassis dynamometer**
- The test condition shall be the same as the type approval condition.
- The test termination should be same as the type approval condition.
- Agree with local regulation on minimum SOC levels

It is allowed to complete the charging by applying a slower charging rate with/without waiting time if the selected power/c-rate charging does not allow to reach the full charged status

Different from method 1a, 1b

Different from method 1a, 1b



Questions about alternative method in comments

1. Introduction of coast down calculation procedure, HD chassis dynamometer setting, HD chassis dynamometer characteristics.
2. Introduction of define and requirement about DS_1 and DS_2 , CSS_M and CSS_E in shortened cycle test method.
3. Why is the different between the HDVs speed tolerance requirement and LDVs?
4. The UBE test method of HD-OVC-HEVs is further explanation.

1. Coastdown Test Method on road and HD chassis dynamometer in UBE test

coastdown test on road

Resistance coefficient can be obtained by two ways:

- ❑ coastdown test on road (allow segmented test)
- ❑ The manufacturer provided and approved by responsible authority

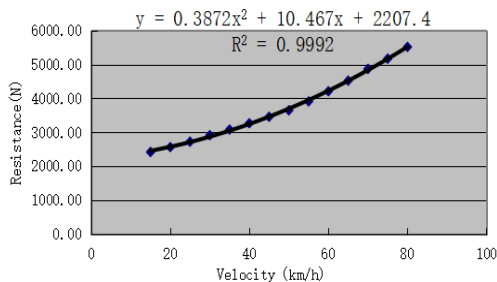
- The vehicle is accelerated to the maximum speed on the test road, the transmission is set in neutral and the vehicle is left coasting until the speed is less than 15km/h.
- The vehicle needs to conduct a test in both directions on the same road, which two tests are called a group test .
- coast down test need to conduct at least 4 group.

Calculation method:

$$F_i = \frac{M \times 2\Delta v}{3.6 \times t_{average}}$$

$$F = k \cdot F_i$$

F_i : running resistance at i speed
 M : vehicle test mass
 Δv : speed deviation of v_1 to v_2
 $t_{average}$: two tests average time at i speed
 k : resistance correction coefficient



The resistance coefficients A, B and C are quadratic term, primary term and constant term, respectively

A=2207.4; B=10.4670; C=0.3872

least squares fit method

chassis dynamometer coastdown test



Coastdown test is simulated on chassis dynamometer to determine the set resistance coefficient A, B, C

- ① Fix the vehicle on the chassis dynamometer to ensure the safety of the test
- ② Change the chassis dynamometer total mass of vehicle to equivalent inertia I
- ③ Reproduce the coastdown time t of vehicle on the road from v_2 to v_1 and determined the absorbed power P_a

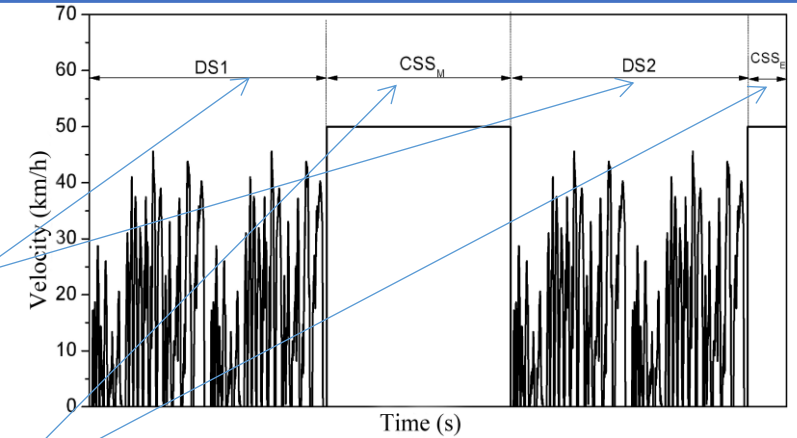
Chassis dynamometer characteristic

- 1) The chassis dynamometer realizes the drive power absorption and inertia simulation through the electric inertia;
- 2) It has the measurement function of time, speed, driving distance and braking function;
- 3) The road simulation fan can synchronize with the car speed

2. The Alternative method——shortened cycle test method

Test cycle sections: **DS₁** and **DS₂**; Constant speed sections: **CSS_M** and **CSS_E**

- Shortened cycle test method consists of test cycle sections (DS₁ and DS₂) and constant speed sections (CSS_M and CSS_E).
- The test cycle shall be determined by CPs . For example, referring to the Title 40 of the Code of Federal Regulation(FTP75 cycle), and the China stage 3 or 4 vehicle fuel consumption (C-WTVC cycle or CHTC cycle).
- The constant speed sections (CSS_M and CSS_E) can be carried out at a higher speed to discharge as soon as possible and reduce the test time.
- The constant speed base on the vehicle category and characteristic regional speeds or base on manufacturer suggestion to determined and agreement with the local authorities.



- DS₁ and DS₂ consist of test cycles.
- CSS_M and CSS_E are constant speed segment.

The constant speed of CSS_M and CSS_E

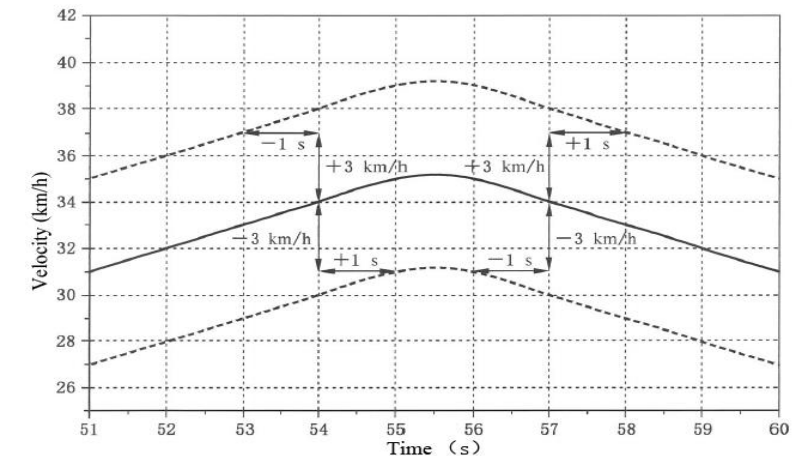
| | City bus | Bus | Truck | Dump truck | Semi-tractor |
|-----------|----------|---------|---------|------------|--------------|
| Recommend | ≥40km/h | ≥80km/h | ≥70km/h | ≥60km/h | ≥70km/h |

Tolerance requirement

The LDV speed tolerances adopt GTR 15: Speed tolerances greater than those prescribed shall be accepted provided the tolerances are never exceeded for more than 1 second on any one occasion. There shall be no more than ten such deviations per test cycle.

The HDVs total mass are greater than that of LDVs, and the driving inertia is larger. The speed deviation requirements of GTR 15 are not easy to meet for HDV. It is recommended that:

the speed tolerance shall be $\pm 3\text{km/h}$, the time shall be $\pm 1\text{s}$, and the total deviation time of each cycle shall not exceed [15s]



3. The Alternative method for HD-OVC-HEVs UBE Test

HD-OVC-HEVs UBE test including three stage: Charge-depleting stage; Charge adjustment stage; Charge balance stage

Three stage:

- **Charge-depleting stage** (discharge)

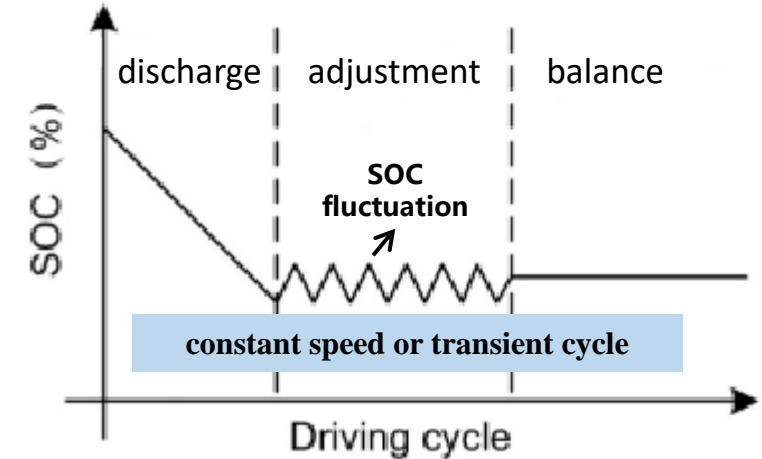
The powertrain runs by consuming only electric energy from the battery until the speed tolerance is exceeded or the engine is started

- **Charge adjustment stage**

The powertrain run by consuming the electric energy from the mains along with the fuel energy simultaneously until the charge-balance stage is reached.

- **Charge balance stage**

The powertrain run by consuming the fuel energy while sustaining the electric energy of the REESS



- ① HD-OVC-HEVs UBE test condition shall be determined by CPs, which can be transient cycle or constant speed cycle.
- ② Refer to SAE J2711, the end of discharge criterion is reached when the net energy change of REESS relative to the total drive energy of the cycle ($REEC_i$) is less than 5%.
- ③ If the test adopts constant speed, each 1800s is considered as a cycle to calculate the cycle total drive energy.

$$REEC_i = \frac{|\Delta E_{REESS,i}|}{E_{cycle} \times \frac{1}{3600}}$$

An example of the UBE test at type approval in China

UBE test results under different conditions

Test temperature: Normal temperature 25°C (Air conditioner is off)
High temperature 35°C (Air conditioner cooling mode is on) ,
Low temperature, -7°C (Air conditioner heating mode is on)

Test vehicle: semi-tractor

Test mass: 49,000kg (GVW)

Test method: Alternative method base on HD chassis dynamometer

| item | 25°C | 35°C | -7°C |
|----------------------------|--------------|--------------|--------------|
| UBE of E_{RESS} /(Wh) | 334881.7 Wh | 345144.3 Wh | 315728.2 Wh |
| driving range/(km) | 195 km | 193 km | 148 km |
| energy consumption/(Wh/km) | 1715.2 Wh/km | 1785.2 Wh/km | 2124.8 Wh/km |
| SOC change/(%) | (99%-19%) | (99%-19%) | (98%-19%) |

The same battery discharging test method must be applied at type approval and during in-service testing Part A verification.

The test temperature shall be same both type approval and during in-service testing Part A verification