中汽中心 | 全国汽车标准化技术委员会
National Technical Committee of Auto Standardization

Energy consumption test methods for heavy-duty commercial vehicles in China

CATARC, 23.May 2024

Related standards

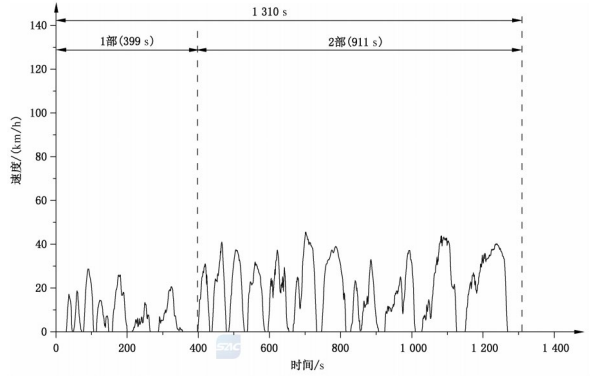
- China has released energy consumption testing methods covering various types of fuel vehicles, **including traditional fuel vehicles, hybrid electric vehicles, battery electric vehicles**, fuel cell vehicles, natural gas vehicles and methanol vehicles.

1. **Traditional fuel vehicles**
   GB/T 27840-2021 Fuel consumption test methods for heavy-duty commercial vehicles
   (First version issued in 2008)
2. **Hybrid electric vehicles**
   GB/T 19754-2021 Test methods for energy consumption of heavy-duty hybrid electric vehicles
   (First version issued in 2005)
3. **Battery electric vehicles**
   GB/T 18386.2-2022 Test methods for energy consumption and range of electric vehicles - Part 2: Heavy-duty commercial vehicles
   (First version issued in 2005)
4. **Fuel cell vehicles**
   GB/T 43252-2023 Test methods for energy consumption and range of fuel cell electric vehicles
   (First version)
5. **Natural gas vehicles**
   GB/T 29125-2012 Test methods for fuel consumption of CNG vehicles
   (First version)
6. **Methanol vehicles**
   QC/T 1130-2021 Measurement methods for fuel consumption of methanol vehicles
   (First version)

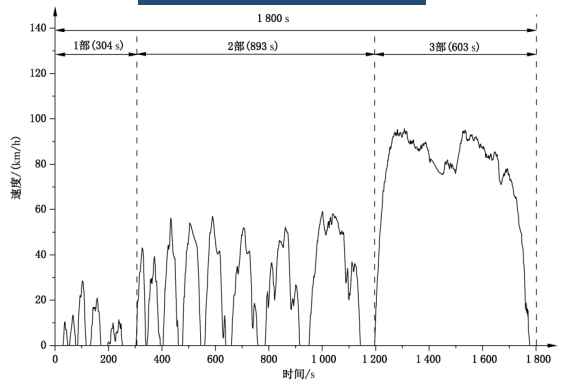
1. Traditional fuel vehicles

- GB/T 27840 applies to vehicles fueled with gasoline or diesel with a technically permissible maximum laden mass exceeding 3,500 kg, including trucks, tractor-trailers, coaches, dumpers, and city buses
- The tests should be conducted according to China Automotive Test Cycles, and vary for different vehicle types.

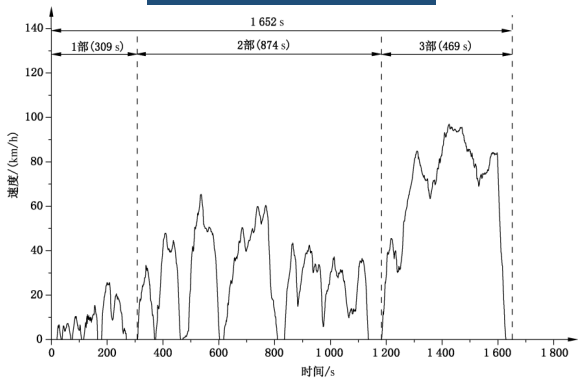
City buses



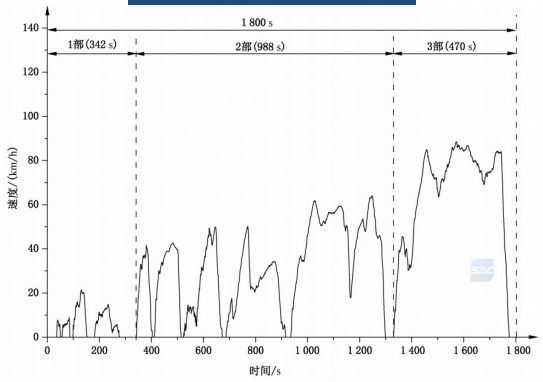
Coaches



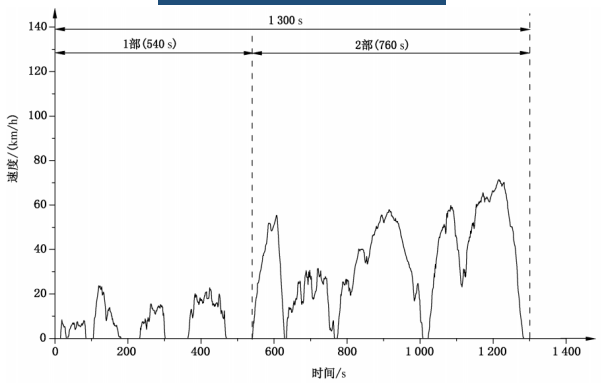
Trucks (GVW≤5500kg)



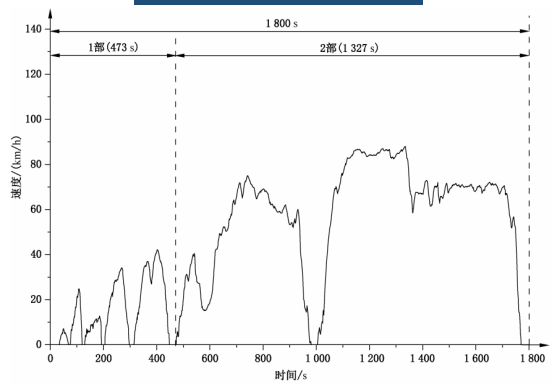
Trucks (GVW>5500kg)



Dumpers



Tractor-trailers



1. Traditional fuel vehicles

■ Test requirements and procedure

01 Test methods

Basic vehicles should use chassis dynamometer method; Variant vehicles should have the option to use chassis dynamometer method or simulation method

02 Road load

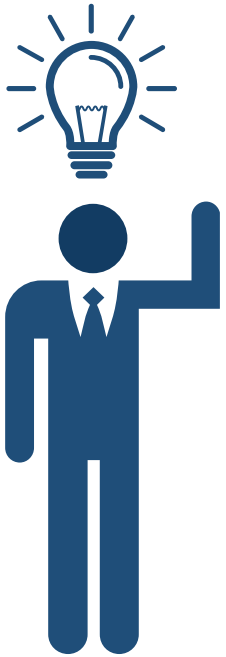
Coastdown method, torque meter method, lookup table method

03 Atmospheric temperature

The recommended atmospheric temperature is 23 ℃± 5 ℃

04 Preconditioning

It is advisable to conduct 1-2 complete test cycles or use other methods to fully preheat the test vehicle and chassis dynamometer



05 Gear shift

Vehicles with energy-saving driving instructions can shift gears according to the corresponding instructions.

06 Test procedure

The vehicle test should run 3 complete test cycles

07 Speed requirements

The speed deviation is ± 3km/h. The single time exceeding the speed deviation should not exceed 2s, and the cumulative time should not exceed 15s

08 Special treatment

When the test vehicle cannot reach the acceleration or test speed required by the test cycles, the accelerator pedal should be fully pressed to the bottom, and this operation is not counted as a single or cumulative time exceeding the speed deviation

1. Traditional fuel vehicles

■ The road load

The determination of the road load of a test vehicle and the transfer of that road load to a chassis dynamometer:

- Coastdown method
- Torque meter method
- Lookup table method

表 E.1　货车行驶阻力系数推荐值

最大设计总质量(*GVW*) kg	常数项(*A*) N	一次项系数(*B*) N/(km/h)	二次项系数(*C*) N/(km/h)²
3 500	477.5	2.00	0.102
4 500	540.5	2.53	0.109
5 500	603.4	3.06	0.115
7 000	697.9	3.86	0.125
8 500	792.3	4.65	0.135
10 500	918.2	5.72	0.148
12 500	1 044.1	6.78	0.161
16 000	1 264.4	8.64	0.184
20 000	1 516.2	10.77	0.210
25 000	1 830.9	13.43	0.242
31 000	2 208.6	16.62	0.281

For vehicles with other gross vehicle weight, the interpolation method should be used.

E.2　其他行驶阻力系数计算

除表 E.1～表 E.5 中规定的最大设计总质量的行驶阻力系数外，其他质量车型可插值计算相应的 A、B、C 系数推荐值。

例如，某车型最大设计总质量为 M，在相应的推荐表中位于 M_1 和 M_2 质量之间，M_1 和 M_2 对应的常数项分别为 A_1 和 A_2，则该车型的行驶阻力常数项按照公式(E.1)确定：

$$A = A_1 + \frac{M - M_1}{M_2 - M_1} \times (A_2 - A_1) \quad \cdots\cdots (E.1)$$

B、C 系数的插值计算方法同理。

1. Traditional fuel vehicles

■ Test results

➢ **Use one of the following three method:**

01 **Carbon balance method**

02 **Weighing method**

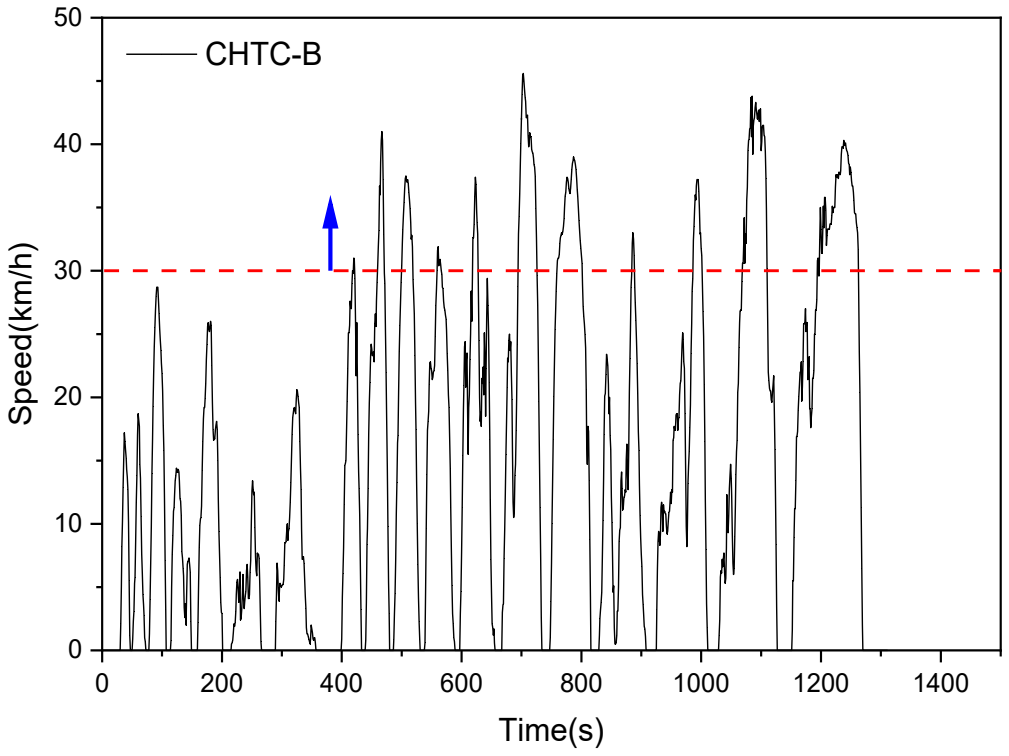
03 **Volumetric method**

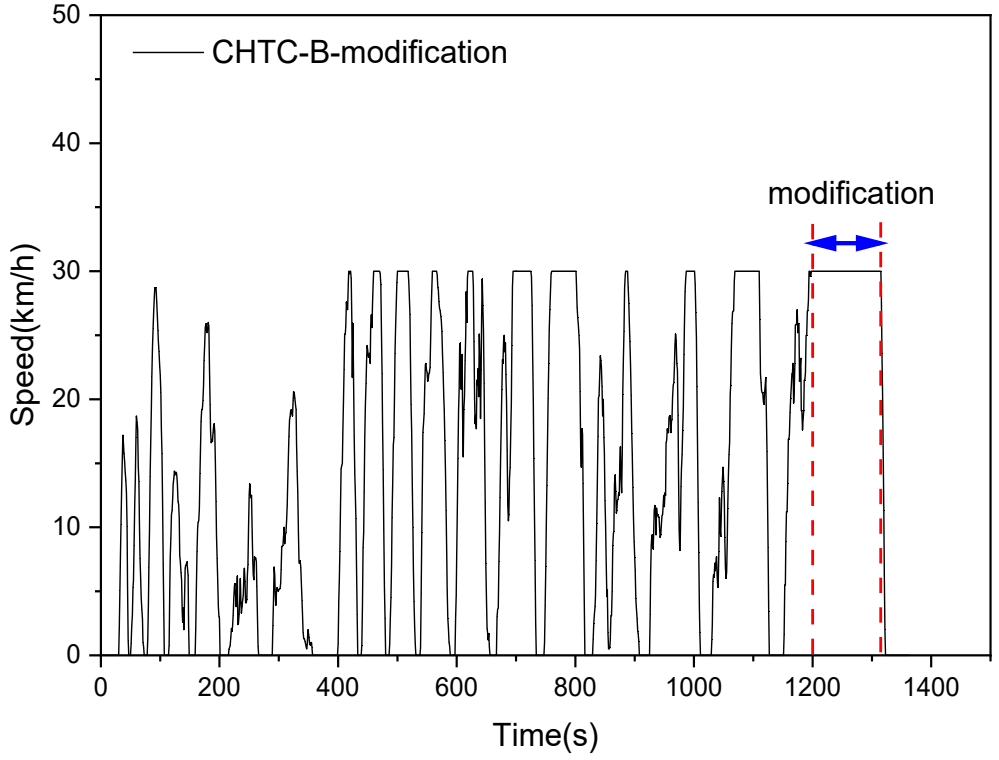
▶ It should be noted that, the National VI emission standard released in 2018 added vehicle emission testing. To achieve simultaneous test of fuel consumption and emissions, currently, the carbon balance method is commonly used

2. Hybrid electric vehicles

- The test cycles, road load setting, etc. are consistent with traditional fuel vehicles. For vehicles with a maximum speed lower than the base test cycle, the base cycle shall be modified in order to achieve the same cycle distance for the capped speed cycle as for the base cycle.

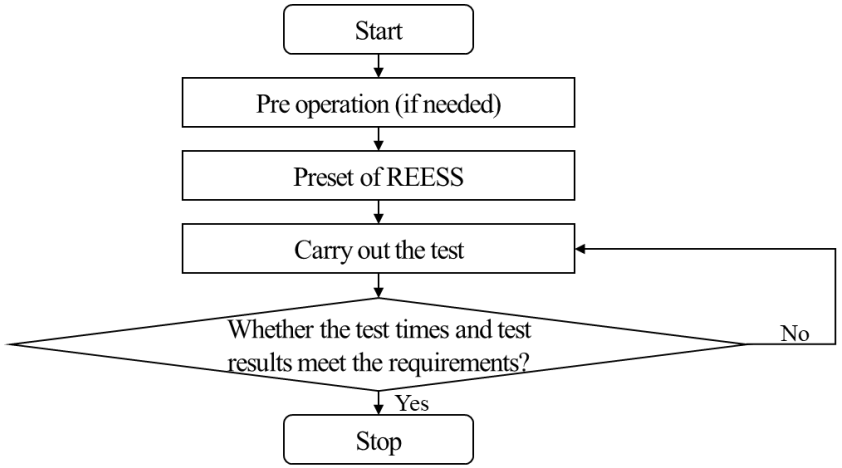
Example: City buses



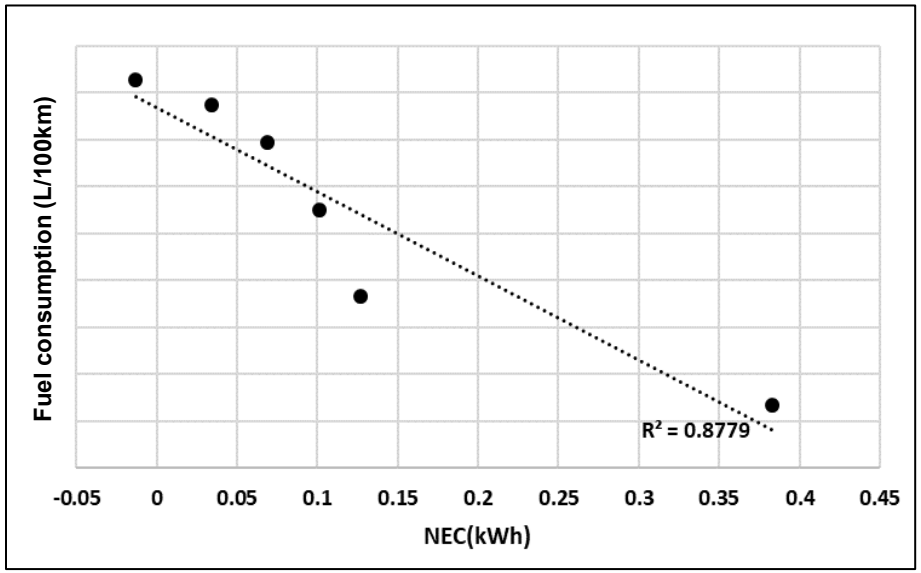


2. Hybrid electric vehicles

■ Test procedure and test results for NOVC-HEV



The test should be conducted at least 3 times. For the vehicles that can achieve charge sustaining, the test results only include fuel consumption, which is obtained through linear regression



For the vehicles that cannot achieve charge sustaining, a maximum number of test cycles has been set, and the test results shall include fuel consumption and energy consumption.

2. Hybrid electric vehicles

■ Test results for NOVC-HEV

Calculate the experimental results based on the energy changes of REESS

$$NEC_{re} = \frac{NEC \times \eta_{tr}}{E_{cycle}} \times 100\%$$

***E_{cycle} is cycle energy demand, same with UN R154 and GTR 15**

For the battery:

$$NEC = k \times \int P dt$$

$$P = k_1 \times U \times I$$

$$I = \eta_c \times I_c - \frac{I_d}{\eta_d}$$

For the supercapacitor: $NEC = k_2 \times C/2 \times \left(U_c^{\,2} - U_b^{\,2}\right)$

▶

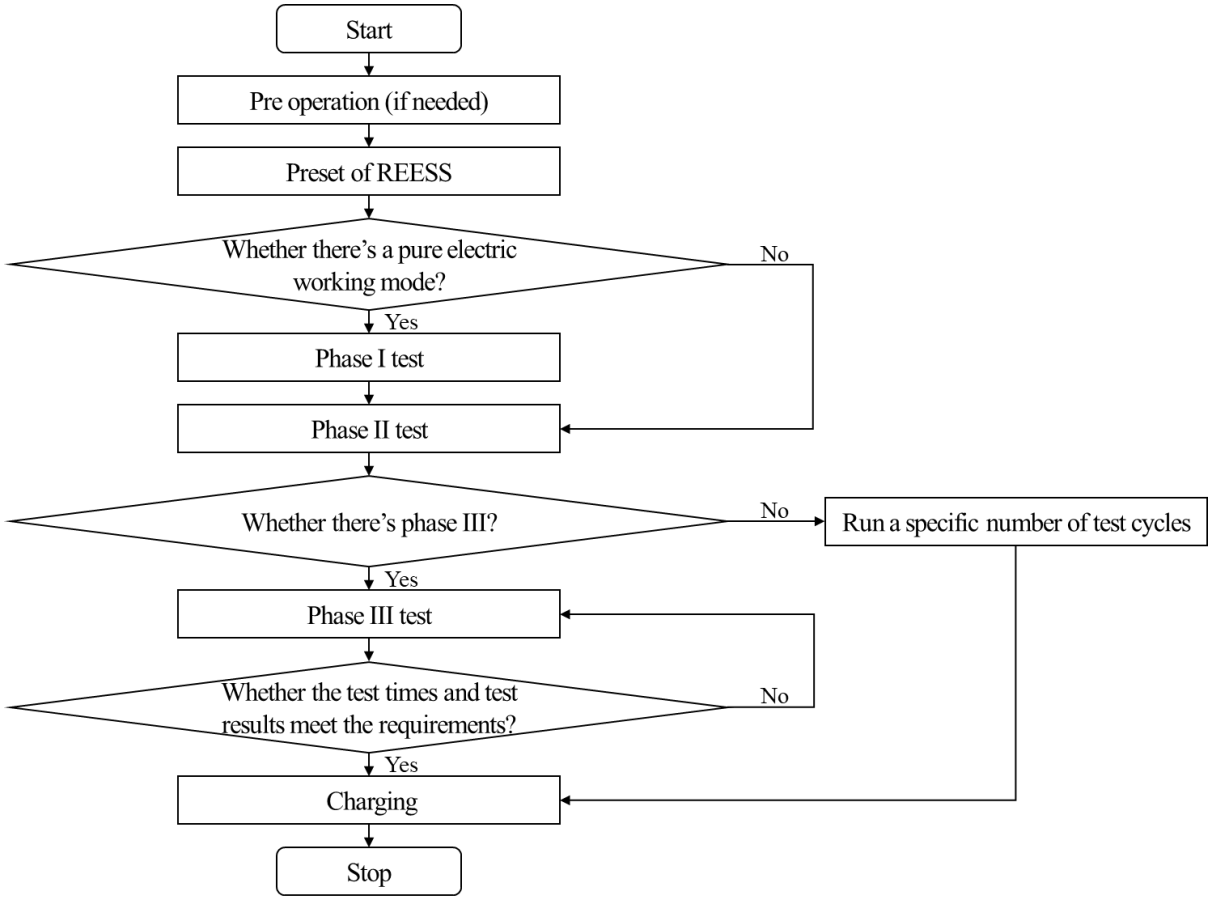
IF $|NEC_{re}| \leq 1\%$, take the average of three test results as the fuel consumption;

IF $1\% < |NEC_{re}| \leq 5\%$, using linear regression to calculate fuel consumption;

IF $|NEC_{re}| > 5\%$, additional tests are required.

2. Hybrid electric vehicles

■ Test procedure for OVC-HEV



Before the test, the vehicle shall be fully charged, and then the three-phase test shall be carried out.

Each of the three-phase test involves multiple test cycles. From the beginning to the engine start, the pure electric phase (phase I*) test ends; then, when the energy balance occurs for the first time, the rechargeable electrical energy storage system (REESS) energy adjustment phase (phase II) test ends; finally, when there are two more energy balance tests occur, the charge sustaining phase (phase III) test ends.

After the test, the vehicle shall be fully charged again and the charging electricity shall be measured.

Some special vehicle types don't include pure electric operation mode or phase III. In this case, special treatment is required.

*It should be note that, during phase I test, the engine start caused by air injection is not considered as the end of the test. The OEMs need to provide corresponding materials to prove that the engine did not participate in the vehicle driving and did not charge the REESS during the air injection process

2. Hybrid electric vehicles

■ Test results for OVC-HEV

➢ Fuel consumption

1. Phase I **(including fuel consumption generated by inflation)**

$$FC_{s1}=\frac{\sum_{c=1}^{n_1}\left(UF_c\times FC_c\right)+UF_{n_1+1}{}'\times FC_{n_1}}{\sum_{c=1}^{n_1}UF_c+UF_{n_1+1}{}'}$$

2. Phase II

$$FC_{s2}=\frac{\sum_{c=n_1+2}^{n_2}\left(UF_c\times FC_c\right)}{\sum_{c=n_1+2}^{n_2}UF_c}$$

3. Phase III

$$FC_{s3}$$

4. Fuel consumption of OVC-HEV

$$FC=FC_{s1}\times\left(\sum_{c=1}^{n_1}UF_c+UF_{n_1+1}{}'\right)+FC_{s2}\times\sum_{c=n_1+2}^{n_2}UF_c+FC_{s3}\times\left[1-\left(\sum_{c=1}^{n_1}UF_c+UF_{n_1+1}{}'\right)-\sum_{c=n_1+2}^{n_2}UF_c\right]$$

➢ Energy consumption

1. Phase I

$$EC_{AC,s1}=\frac{\sum_{c=1}^{n_1}\left(UF_c\times EC_{AC,c}\right)+UF_{n_1+1}{}'\times EC_{AC,n_1}}{\sum_{c=1}^{n_1}UF_c+UF_{n_1+1}{}'}$$

$$EC_{AC,c}=EC_{DC,c}\times\frac{E_{AC}}{NEC_{tot}\times 1000}$$

2. Phase II

$$EC_{AC,s2}=\frac{\sum_{c=n_1+2}^{n_2}\left(UF_c\times EC_{AC,c}\right)}{\sum_{c=n_1+2}^{n_2}UF_c}$$

3. Phase III, equal to 0

4. Energy consumption of OVC-HEV

$$EC=EC_{AC,s1}\times\left(\sum_{c=1}^{n_1}UF_c+UF_{n_1+1}{}'\right)+EC_{AC,s2}\times\sum_{c=n_1+2}^{n_2}UF_c$$

➢ Range

$$S=\frac{NEC_m+NEC_{s1}}{EC_{DC,s1}}\times 1000$$

2. Hybrid electric vehicles

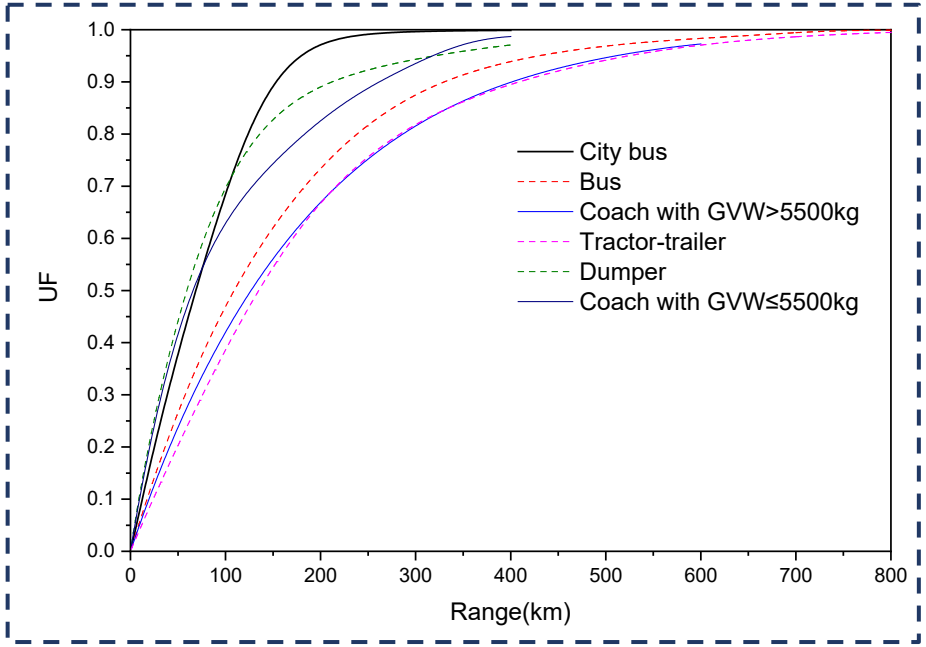
■ Utilization factor (UF)

$$UF_c(d_c) = 1 - \exp\left\{-\sum_{x=1}^{10}\left[C_x \times \left(\frac{\sum_{l=1}^{c} d_l}{\mathrm{d_n}}\right)^x\right]\right\} - \sum_{l=1}^{c-1} UF_l$$

Utilization factor (UF) is fitted according to the actual one-day travel characteristics in China. It is gradually tends to 1 with the increase of driving range, giving different weight coefficients per cycle. Based on UF, the comprehensive energy consumption of PHEV can be obtained.

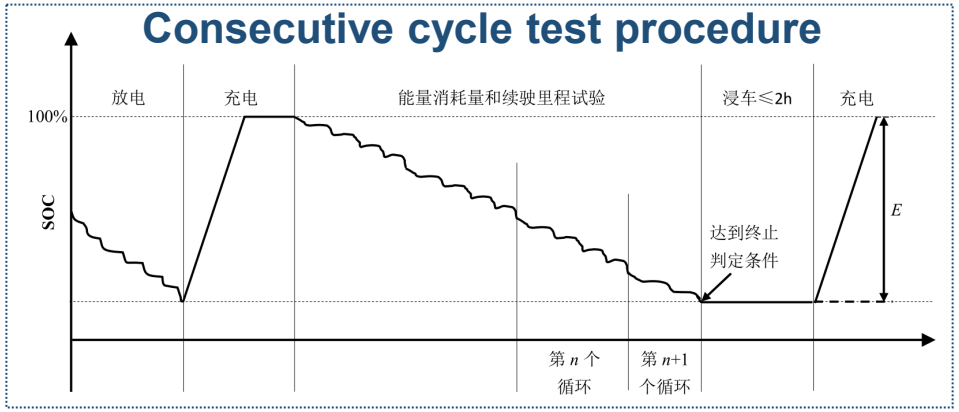
表C.1 *UF* 确定参数

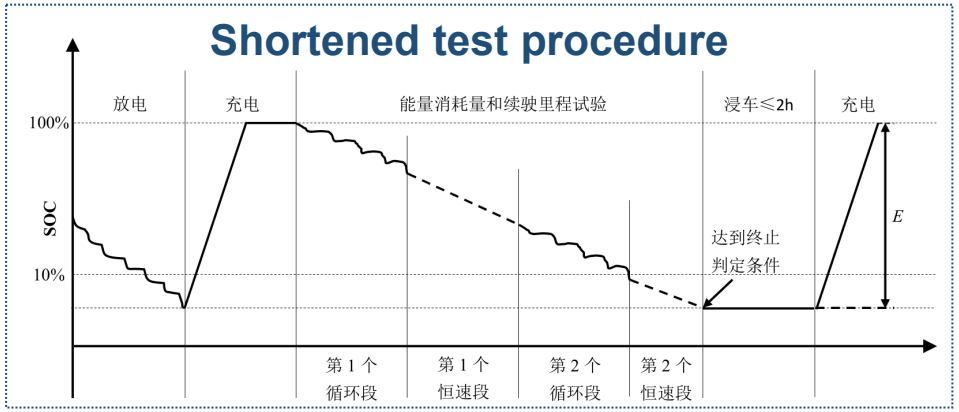
参数	城市客车	客车	货车（GVW≤5500kg）	货车（GVW＞5500kg）	自卸汽车	半挂牵引车
d_n	400	800	400	600	400	800
C_1	3.18	4.81	4.42	3.24	4.91	3.49
C_2	8.12	0.33	0.59	0.48	-7.03	0.30
C_3	-49.17	62.24	-20.82	-6.96	63.34	35.26
C_4	201.35	-784.54	139.77	60.34	-231.50	-66.13
C_5	37.99	4703.91	-879.02	-267.01	417.41	-347.39
C_6	-1411.19	-15387.39	3208.28	693.50	-429.57	1609.59
C_7	2883.95	29007.71	-6366.91	-1086.35	265.94	-2808.48
C_8	-2627.03	-31532.57	6940.43	1004.14	-98.18	2530.98
C_9	1163.51	18369.07	-3915.85	-502.56	19.92	-1178.21
C_{10}	-204.04	-4436.42	893.45	104.78	-1.71	225.85

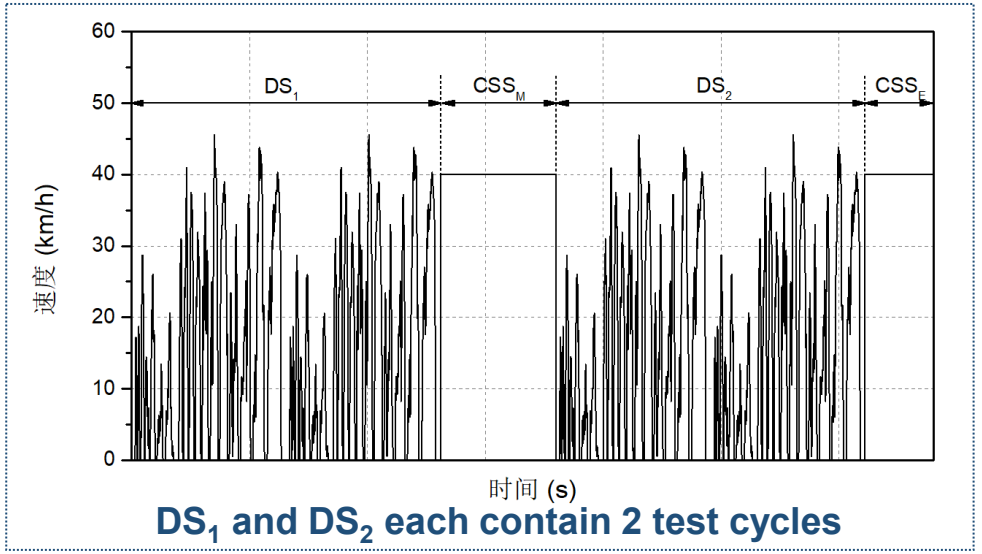


3. Battery electric vehicles

- The test cycles, road load setting, test cycles, etc. are consistent with HEV.
- The GB/T standard specifies two methods: consecutive cycle test procedure and shortened test procedure







3. Battery electric vehicles

■ The calculation method for range varies under different methods, but for energy consumption is the same

➢ Range

➢ Consecutive cycle test procedure

$$BER = \frac{E_{\text{REESS,CCP}}}{EC_{\text{DC}}},\quad EC_{\text{DC}} = \sum_{c=1}^{n}\left(EC_{\text{DC},c} \times K_c\right),\quad K_c = \begin{cases} \dfrac{\Delta E_{\text{REESS},c}}{E_{\text{REESS,CCP}}}, (c \le 2) \\ \dfrac{1-K_1-K_2}{n-2}, (c > 2) \end{cases}$$

1. Distinguish the energy consumption between the first two test cycles and the subsequent test cycles;
2. *N* is the complete number of test cycles, excluding the last incomplete test cycle.

➢ Shortened test procedure

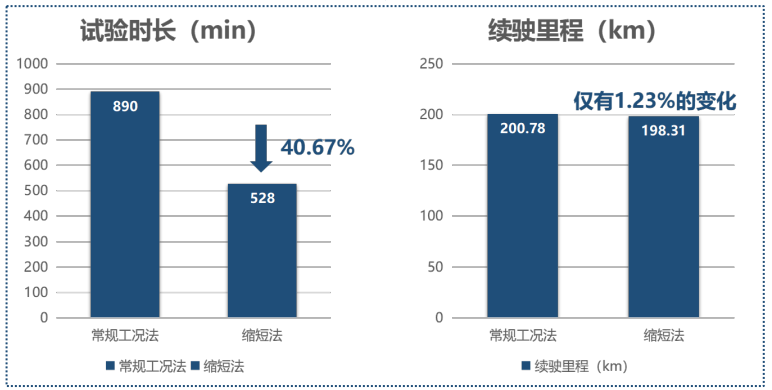
$$BER = \frac{E_{\text{REESS,STP}}}{EC_{\text{DC}}},\quad EC_{\text{DC}} = \sum_{c=1}^{4}\left(EC_{\text{DC},c} \times K_c\right),\quad K_c = \begin{cases} \dfrac{\Delta E_{\text{REESS,DS}_c}}{E_{\text{REESS,STP}}}, (c \le 2) \\ \dfrac{1-K_1-K_2}{2}, (c > 2) \end{cases}$$

1. The first two test cycles only represent that cycle, while the last two test cycles represent the energy consumption of all cycles after the first two test cycles with the same weight.

➢ Energy consumption

Calculate energy consumption based on driving range and external charging

$$EC = \frac{E_{\text{REESS,CCP(STP)}}}{E_{\text{REESS,CCP(STP)}} + \Delta E_{\text{REESS,af}}} \times \frac{E_{\text{AC}}}{BER}$$

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