

# **Proposal for Battery Durability Test of HD-OVC-HEV**

China, January 09, 2024

# Driving condition differences between HD-OVC-HEV with HD-PEV

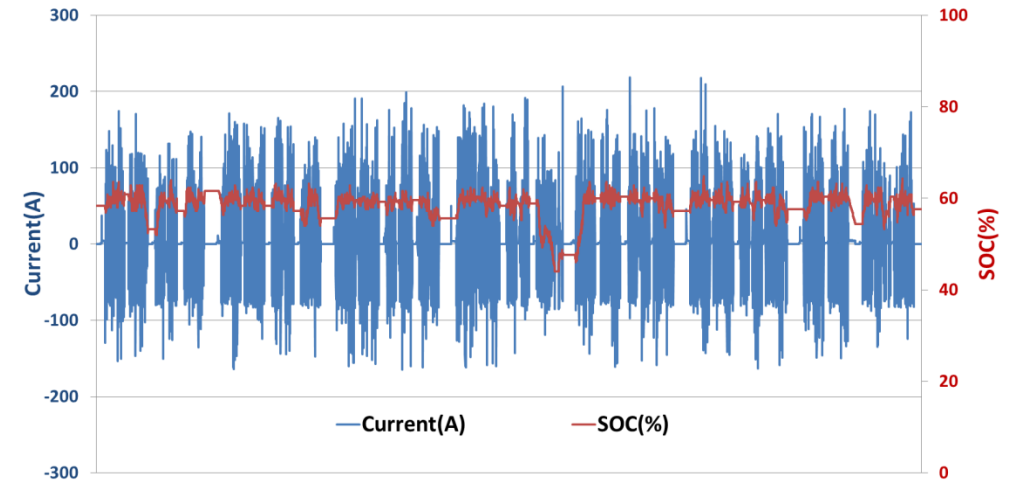
## ❑ For HD-OVC-HEV bus (48Ah/30kWh battery system)

- ✓ Customers seldom use pure electric mode to drive and rarely charge, because the energy of battery is low.
- ✓ The battery SOC remains around 60% and fluctuates within the range of 40% to 80%.
- ✓ The discharge current and feedback current are basically equivalent, the maximum is nearly 200A, corresponding to 4C rate.

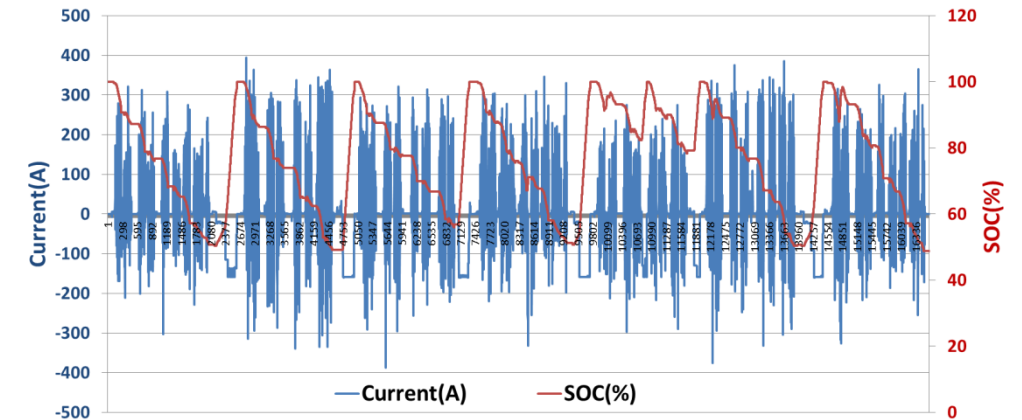
## ❑ For HD-PEV bus (456Ah/230kWh battery system)

- ✓ Customers use pure electric mode to drive and basically charge once a day.
- ✓ The variation range of battery SOC is and fluctuates within the range of 0% to 100%.
- ✓ The discharge current is significantly higher than feedback current, the maximum is nearly 400A, corresponding to 1C rate.

Buses as examples



Driving data of HD-OVC-HEV for a week



Driving data of HD-PEV for a week

# Driving condition differences between HD-OVC-HEV with HD-PEV

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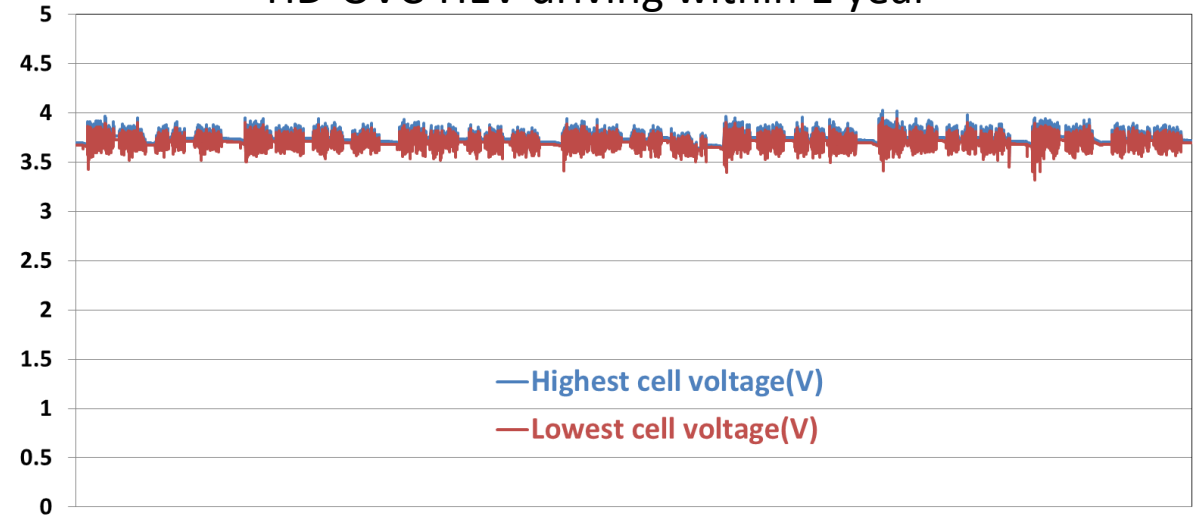
## □ Characteristics of HD-OVC-HEVs (v.s. HD-PEVs )

- ✓ The energy supply is much less than HD-PEVs
- ✓ The endurance range of pure electric mode is lower, which almost lower than 100km
- ✓ seldom driving at of pure electric mode
- ✓ Narrow range of SOC
- ✓ Depth of discharge is small
- ✓ Higher discharge and feedback rate

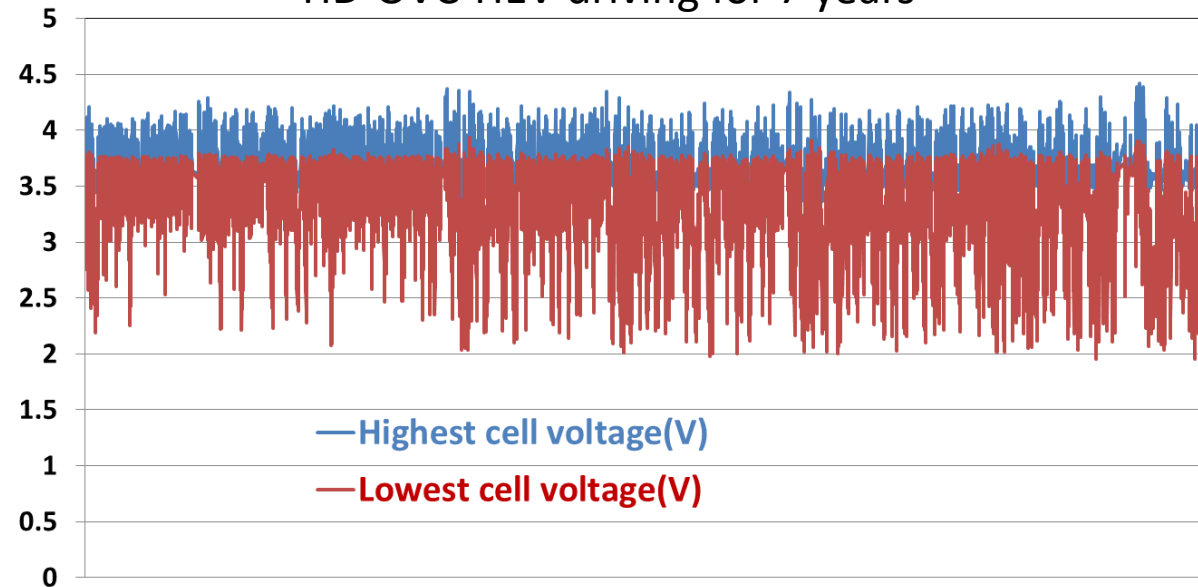
# Battery Aging performance of HD-OVC-HEV

- ❑ The variation range of cell voltage for new vehicles is about 3.2~4V. While after 7 years driving the variation range of cell voltage increases to 2~4.4V, which Exceeds the BMS limit, Resulting in Power output limitation of vehicle.
- ❑ With the increasing of using years, the variation range of cell voltage is larger, which means the power performance of battery descends, resulting in the increased fuel consumption of vehicles.
- ❑ The increased range of cell voltage is because the internal resistance increases with battery aging, the polarization of electrochemical reactions deteriorates sharply with the high discharge and feedback rate.

HD-OVC-HEV driving within 1 year



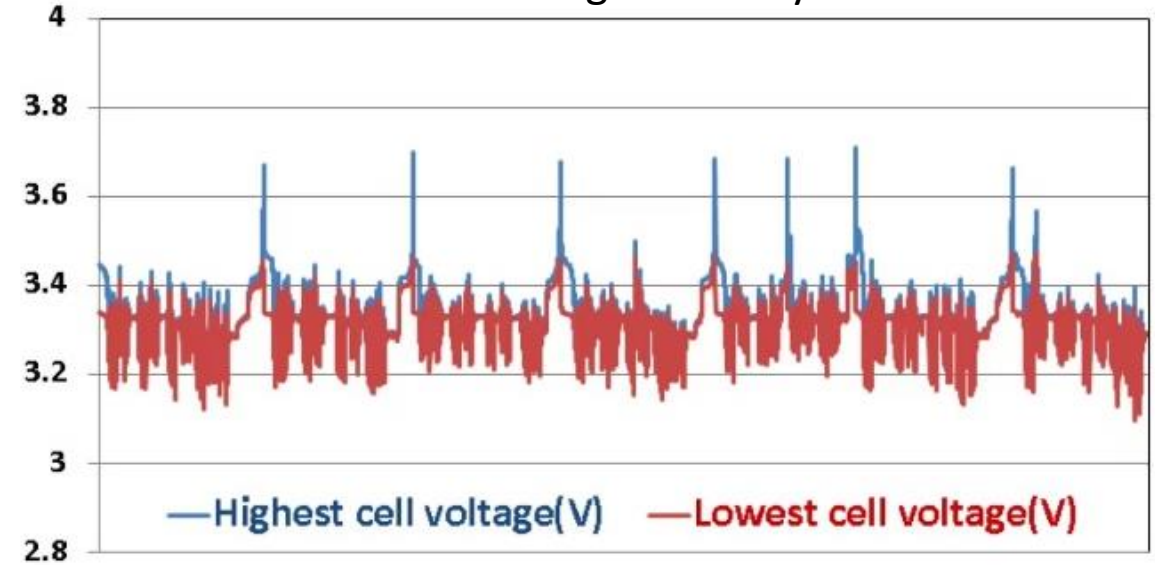
HD-OVC-HEV driving for 7 years



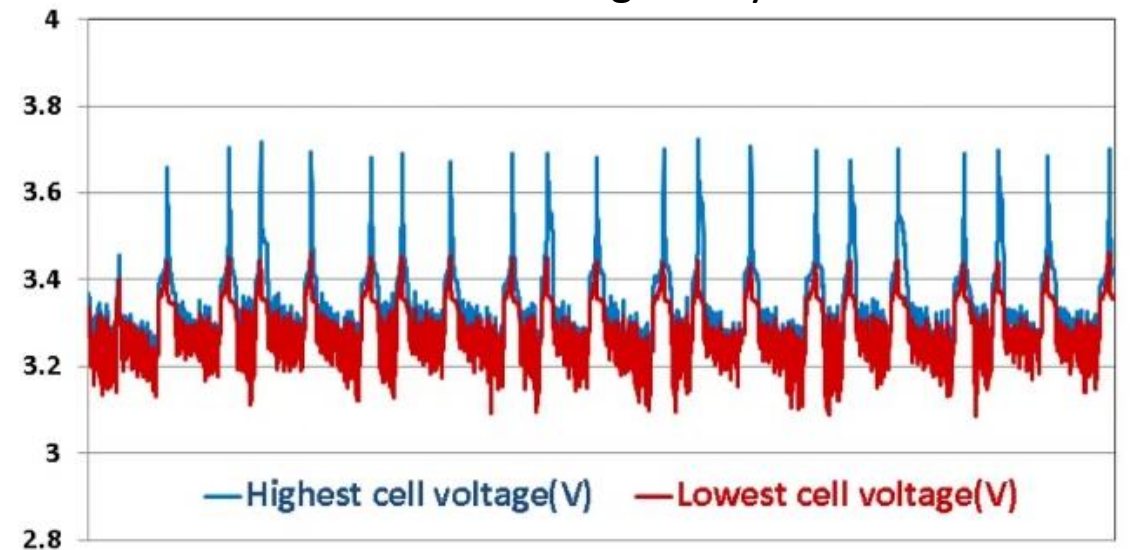
# Battery Aging performance of HD-PEV

- ❑ The variation range of cell voltage for HD-PEV is about 3.1~3.7V. There is no significant difference in the voltage variation range between new and old vehicles.
- ❑ With the increasing of using years, the UBE of battery decreases, which means the shortened endurance range of vehicles, resulting in more cycles and charge count in one day.
- ❑ During the battery attenuation process of HD-PEV, the polarization voltage has negligible variation, because the low discharge and feedback rate corresponding to HD-OVC-HEV.

HD-PEV driving within 1 year



HD-PEV driving for 7 years



# Proposal for Battery Durability Test of HD-OVC-HEV

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- ❑ For HD-OVC-HEVs, the energy supply and endurance range are much less than HD-PEVs, and the discharge and feedback rate are much higher than HD-PEVs. The HD-OVC-HEVs require the batteries with high power density.
- ❑ For HD-OVC-HEVs, pure electric mode is using rarely, so customers may not sensitive to the endurance range of pure electric mode.
- ❑ For HD-PEVs, there is no significant increase in the voltage variation range during the battery attenuation process, because the low discharge and feedback rate corresponding to HD-OVC-HEVs. The declined UBE of battery and the shortened endurance range of vehicles are main characteristics of battery attenuation. **The constant velocity and transient cycle methods are both OK to verify the battery durability.**
- ❑ For HD-OVC-HEVs, the variation range of cell voltage increases and the output power performance of battery significantly decreases during the battery attenuation process, because the increasing internal resistance and electrochemical polarization of battery with the high discharge and feedback rate. It will be result in the higher fule consumption. **The transient cycle method is better to verify the battery durability of HD-OVC-HEVs, because the accelerate and brake conditions of the transient cycle method is favor to verify the output power performance attenuation of HD-OVC-HEVs.**