GTR-EVS TF6 – State of Charge

Standards for REESS Self-Discharge Performance

Background

At Brussel TF-Mtg potential discharge during preparation period following initial charging and actual start of test has been discussed.

Potential issues are seen with REESS being prepared for tests at component level and with preparation of non-externally charging HEV vehicles, while no issue is generally seen with externally chargeable vehicles. Potentially critical cases:

- HEVs: the actual depletion is strongly dependent on preservation measures taken at vehicle level. The issue is reflected already in the proposal for the initial charging procedure.
- Testing as REESS component level: As representative data from manufacturers and technical services is not available, Technical Standards have been evaluated related to the level of self-discharge of REESS for automobile applications, e.g.:
  - ISO-12405 Parts 1 and 2 define test procedures for „Capacity Loss at Storage“ for 30 day periods at 40°C environmental conditions (Clause 7.5).
    The tests are applicable to REESS level with all required instrumentations. The standard does not define pass/fail-criteria.
  - GB/T 31486 allows a max. 15% self-discharge for Li-Ion REESS within a period of 28 days.
  - US DoE Battery Test Manual recommends a max. discharge of 1% for a 30 day period (remark: this is in relation to a 45kWh system)

ISO 12405 Part 1 and 2

7.5 Capacity loss at storage

7.5.1 Purpose

This test is to measure battery system capacity loss when the battery system is stored for an extended period of time, analogous to the situation that occurs when the battery system is shipped from a manufacturer to a customer. This loss, if it occurs, may be due to self discharge, which is normally temporary, or to other mechanisms that could produce permanent or semi-permanent loss of capacity.

This test applies to battery systems only.

7.5.2 Test procedure

The self discharge behaviour shall be measured with a complete and fully operational battery system. During the storage period, all battery system terminals are disconnected (e.g. HV connections, LV connection, cooling). The service disconnect device, if any, shall be disconnected.

The self-discharge rate of the battery system shall be measured after a 720 h (30 days) rest period at 45 °C ambient temperature with an initial SOC of 50 %. The remaining capacity after the storage period shall be determined by a 1C discharge.

The storage test shall be performed in a temperature controlled test chamber at 45 °C ….

GB/T 31486-2015 -

Electrical Performance Requirements and Test Methods for Traction Battery of Electric Vehicle

5.2.9 Charge retention and capacity recovery

In the case of lithium-ion battery module, when tested as per 6.3.10, its charge retention at room temperature and high temperature shall be no less than 85% of the initial capacity, and its capacity recovery shall be no less than 90% of the initial capacity.

In the case of nickel metal hydride battery module, when tested as per 6.3.10, its charge retention at room temperature shall be no less than 85% of the initial capacity, its charge retention at high temperature shall be no less than 70% of the initial capacity, and its capacity recovery shall be no less than 95% of the initial capacity.

6.3.10 Charge retention and capacity recovery

6.3.10.1 Charge retention and capacity recovery at room temperature

Charge retention and capacity recovery at room temperature shall be tested as per the steps below:

a. Charge battery module as per the procedures of 6.3.4;
b. Soak battery module at room temperature for 28 days;
c. At room temperature, discharge battery module at the current of 1I1(A), until the voltage of any secondary cell reaches the end-of-discharge voltage;
d. Determine the charge retention capacity (expressed in Ah);
e. Then, charge battery module as per the procedures of 6.3.4;
f. At room temperature, discharge battery module at the current of 1I1(A), until the voltage of any secondary cell reaches the end-of-discharge voltage;
g. Determine the capacity recovery (expressed in Ah).

3.6 Self-Discharge Test

This test is intended to determine the temporary capacity loss that results from a cell or battery standing (i.e., at rest) for a predetermined period of time (i.e., 30 days at 30°C).

The test consists of the following sequence of activities:

1. Measure the actual device capacity from full charge ($Vmax_{op}$) to the discharge voltage limit ($Vmin_0$) using a constant C/3 rate, and recharge it using the manufacturer's recommended charge algorithm.
2. Remove the half of the Available Energy from Table 1 (45 kWh at the system level or as specified by the manufacturer for the cell-level) at the C/3 rate. Allow it to stand in an open-circuit condition for a nominal interval of 30 days. All measurement equipment may need to be disconnected from the device during this period to reduce parasitic losses.
3. Discharge the device to Vmin0 for its remaining (residual) capacity at the C/3 rate.
4. Recharge the device and fully discharge it again at the C/3 discharge rate. If a loss of capacity is observed between (1) and (4), additional recharge/discharge cycles (up to 10 cycles) may be performed to return the device to its nominal capacity.

Table 1. Energy Storage System Performance Targets for Electric Vehicles

End of Life Characteristics at 30°C	**Units**	**System Level**	**Cell Level**
…			
Maximum Self-Discharge	**%/month**	**< 1**	**< 1**

Conclusion

- Established standards require discharge-levels of REESS systems far below a 5% ratio for 48h.
- As a consequence in normal practice less than 1% discharge would be expected between charging and start of test under typical certification conditions and assuming appropriate treatment of the REESS within this period.
  For any test on REESS level conducted within 48h after final charging the expected loss of charge is expected to be insignificant.