Review of Options for EVE on Battery Durability

From Status Report of May 2017 (EVE 23-05e.pdf)

Four approaches to battery durability

- Originally detailed in “Options for EVE on Battery Durability”, May 2017 (EVE-23-05e.pdf)
  - Conceived as **lines of inquiry** or **organizing principle** for continued EVE activity
  - Each approach has its own set of feasibility requirements to be researched
  - Each approach has implications for the EVE activity necessary to investigate it
  - Some approaches may be better suited for some types of vehicles than others
- Approach A: Pursue Development of Durability Test Profile(s)
- Approach B: Seek to Identify Default Deterioration Factors (DFs)
- Approach C: Investigate Testing with Aged or Age-Emulated Battery
- Approach D: Use Simulation to Determine DF or Expected Degradation

Approach A: Develop Durability Test Profiles

- Investigate the potential for durability test profiles to be developed for the testing of vehicles or batteries, for use by a manufacturer to demonstrate compliance with a durability standard.
- A “test profile” is any combination of factors known to affect battery degradation, for example:
  - Usage of vehicle (driving cycle or duty cycle)
  - Temperature (ambient or internal, during use and storage)
  - Charging rate, frequency and type of charging
  - Calendar time, parking time

Approach B: Identify Deterioration Factors

- Certification testing for environmental performance would take place at beginning-of-life (BOL)
- Environmental performance at end-of-life (EOL) would be estimated by applying a DF to represent expected degradation at EOL
  - A default DF would be identified (representing “typical” and/or “acceptable” deterioration)
  - Alternatively, the manufacturer could use a custom DF if it can show that it is more applicable to its technology
- Analogous to U.S. EPA range labeling rule

Approach C: Test with Aged Battery

- Certification testing takes place on a test vehicle configured to behave like a deteriorated vehicle
- Several potential concepts:
  - Installed with aged battery
    - Bench-aged (according to a protocol yet to be identified -- accelerated)
    - In-use aged, in vehicle (accelerated also)
  - Hardware modified battery
  - Software-limited test mode
- Analogous to testing for criteria pollutants with bench-aged catalyst

Approach D: Use Simulation to Determine DFs or Expected Degradation

- Develop a simulation model that predicts the degradation that would result from application of arbitrary lifetime usage profiles
- Results might be used to:
  - Determine default DFs for various vehicle types and applications (to support Approach B, as alternative to observing vehicles in use)
  - Or, as a manufacturer certification tool
    - Simulation tool would be appropriately parameterized (chemistry formulation, battery architecture, duty cycle representative of geographic region or customer profile, etc)
    - Manufacturers could supply the model with parameters representing their design
    - Results used to support certification application
- Somewhat analogous to use of LCCP model to predict GHG emissions of mobile air conditioning, or GEM model to support HD certification

LCCP = Life Cycle Climate Performance model. GEM = Greenhouse Gas Emission model

Summary

- The four approaches represent “lines of inquiry” for EVE IWG
- As an organizing principle, it is helpful to cast EVE discussion of battery durability in terms of which Approach it is concerned with
- For example, discussion of JRC simulation tool is an example of inquiry into Approach D