



EU-Commission

JRC Contribution to EVE IWG:

In-vehicle battery durability

34th Meeting of the GRPE Informal Working Group
Electric Vehicles and the Environment (EVE)

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ECU Data to be recorded for use in NUI and battery second life -1

- To be applied to different vehicle segments and technologies BEVs and PHEVs

Lifetime information

- Elapse time since vehicle manufacture (i.e. manufacturing and start of service date)
- Discharge rates: overall km, km driven per month and average km driven per charge
- Charge rates: number of normal charges and fast charges
- Total Ah-throughput and C-rate
- Total time of rest and statistic of the time spent at certain SoC levels
- Self-discharge rates
- SoC windows in system operation of battery (example: average values, worst case and frequency)
- Battery temperature both during operation and inactivity periods: temperature and humidity statistics (example: average, max and min per month)
- Exploring information for different regional settings
- V2G discharge rate and frequency for future applications
- Negative events during lifetime
- Number of balancing actions on cells in a module
- Errors from the BMS

ECU Data to be recorded for use in NUI and battery second life -2

- To be applied to different vehicle segments and technologies BEVs and PHEVs

State of Health related information:

- Remaining capacity (in Ah and KWh) for each module in the battery pack
- Overall capacity fade at pack level and individual cell degradation
- Internal resistance increase in $m\Omega$ for each module in a pack
- Remaining power capability and power fade
- Remaining round trip efficiency
- Actual cooling demand
- Evolution of self-discharge rates
- Electro-chemical impedance
- Battery reserve energy
- Battery Voltage

ECU Data to be recorded for use in NUI and battery second life -3

- To be applied to different vehicle segments and technologies BEVs and PHEVs

Nominal battery information:

- Battery chemistry
- Battery architecture (no. of modules, no. of cells, cell voltage, cell current, series/parallel connection etc.)
- Reference battery voltage [V]
- Battery capacity [Wh]
- Battery reserve [%]

First proposal Vehicle normal usage indices (NUI)

- To be applied to different vehicle segments and technologies BEVs and PHEVs

Normal or extreme usage

- km driven per month: extreme usage more than X km/month?
- Number of charges per type: extreme usage more than X via fast charging?
- Total time of rest: extreme usage more than X months per years?
- SoC levels: extreme usage typically habits to keep it full or empty?
- Battery temperature both during operation and inactivity periods: extreme usage extensively in temperatures higher than 35 C or lower than 7C?
- V2G discharge rate and frequency: extreme usage more than X % of the days in a year ?
- Exploring information for different regional settings that can be extreme usage
- Negative events during lifetime: extreme usage more than X times in Y year?
- Errors from the BMS/vehicles?
- Others?

JRC TEMA Model Review Workshop

- One day model review workshop organized by the JRC, in the framework of EVE IWG, where JRC explains all the features of the model, assumptions and scientific background of each part.
- One month review by the stakeholders for questions, comments, suggestions etc.

Input/output of in-vehicle battery durability module of JRC TEMA platform

Input to JRC TEMA	
General parameters	<ul style="list-style-type: none"> • Age of the car since manufacture [yrs] • Run-in km • Vehicle technology (BEV, PHEV) • EoL threshold for capacity fade and power fade
Environmental parameters	<ul style="list-style-type: none"> • Ambient temperature max and min for each month of the year [°C]
Duty cycle parameters	<ul style="list-style-type: none"> • Average number of trips per month • Average driven distance [km] • Average driving time [h] • Average driving speed [km/h] • Average energy consumption [Wh/km] • Average resting time without charging [h] • Average parking time [sec]
Charging data	<ul style="list-style-type: none"> • Average recharging time [h] • Recharging power [kW] • Charging mode/level • Average number of recharge per month
Battery parameters	<ul style="list-style-type: none"> • Battery chemistry • Battery architecture (no. of modules, no. of cells, cell voltage, cell current, series/parallel connection i.e. 48S-2P-2S etc.) • Reference battery voltage [V] • Battery capacity [Wh] • Battery reserve [%] • Average weighted battery temperature [°C] • Battery temperature min and max (BMS) [°C] • Average battery SoC min driving [%] • Average battery Delta SoC during charging [%] • Average battery SoC parking no charging [%]

HV battery chemistry	Output from JRC TEMA			
	Capacity fade		Power fade	
	Calendar	Cycle	Calendar	Cycle
LiFePO ₄	Sarasketa-Zabala et Al. (2013/14);	Wang et Al. (2011); Sarasketa-Zabala et Al. (2013); Sarasketa-Zabala et Al. (2015);	Sarasketa-Zabala et Al. (2013);	
NCM + Spinel Mn	Wang et Al. (2014);		-	-
NCM - LMO	-	Cordoba-Arenas et Al. (2014);	-	Cordoba-Arenas et Al. (2015);

Thank you for the attention

Q&A

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