

OICA Comments, part B

Technical comments on FEV report EP-C-12-014 WA 3-01

**Battery Durability in Electrified Vehicle Applications: A Review of Degradation Mechanisms and Durability Testing**

Item	Document Reference	Text citation	Comments
1	p. 13, Table 2	Cathode materials LMO listed as Lithium Manganese Oxide (LiMnO <sub>2</sub> ) Lithium Manganese Oxide Spinel (LiMn <sub>2</sub> O <sub>4</sub> ) Lithium Manganese Oxide Spinel Polymer	MnO <sub>2</sub> is used in as cathode material in primary (non-rechargeable) cell technology as the crystalline lattice structure is not supportive of efficient Li ion transport. The spinel is used in secondary (rechargeable) cells due to 3D lattice configuration which is ideal for Li ion mass transport in and out of the cathode material. Kindly identify any cell manufacturer using MnO <sub>2</sub> cathodes for automotive grade batteries or remove listing. LiMnO <sub>2</sub> may occur as a secondary constituent in Mn rich NMC (or NM) cells, but this is different from identifying it as a stand-alone cathode material.  “Lithium Manganese Oxide Spinel Polymer” is not a cathode material. The cathode material is still LiMn <sub>2</sub> O <sub>4</sub> . “Polymer” refers to electrolyte form (e.g. electrolyte is bound in a polymer matrix and not liquid). Separate cathode material entry is not appropriate.
2	p.15, Table 3	LiCoNiMnO <sub>2</sub> and LiNiMnCoO <sub>2</sub> listed as separate entries	Mixed transition metal oxides comprising Mn, Ni and Co dioxides are all NMC materials. The order of the cations in the chemical formula does not make a difference to the material denomination, nor does the specific percentage of each transition metal content.
3	p.15 Table 3	Graphite/LiTiO <sub>2</sub> (LTO)	Inorrect material designation: LTO refers to Lithium titanate, i.e. Li <sub>4</sub> Ti <sub>5</sub> O <sub>12</sub> .  Graphite and TiO <sub>2</sub> (although Li <sub>4</sub> Ti <sub>5</sub> O <sub>12</sub> is more common than TiO <sub>2</sub> )are used as anode material in commercial cells. Graphite is certainly not used as a cathode material in any known Li ion technology available on the market and there are no research activities supporting that this is foreseen.
4	p.16 line 11	“..a zinc-air flow battery is being developed by Revolt...”	ReVolt still on the market? EOS and Powergenix are at least as active on rechargeable Zn/air technology. No clear justification for naming specific company here when not done for other technologies.
5	p.15 line 9 and	Sub-heading: Li ion batteries	Why multiple entries on Li ion batteries

	p.16 line 33	Sub-heading: Li ion batteries	under the same section heading "Battery Technologies for xEV's"?
6	p.16, line 37	"Here, we focus primarily on batteries with a Li CoO <sub>2</sub> cathode and graphite anode..."	Justification? LiCoO <sub>2</sub> cathode chemistries is not the technology of choice for a majority of automotive makers globally. NMC (with a drift towards NM in future battery generations) and LFP technologies are currently dominating.
7	p.16, line 44	"Lithium-ion capacity fade ranges from approximately 12-24% after 500 cycles"	What type of cycles? Needs to be specified in order for relevance and meaning of data to be clear. Can be very misleading!
8	p.17, line 40	"Lithium iron phosphate batteries"	Justification? LFP is a kind of Li ion battery. Why should it be treated independently of other Li ion battery chemistries. Problems specific to LFP (hysteresis, etc) not mentioned. Separate treatment builds on notion that LFP holds a preferential or superior position among Li ion chemistries for xEV, and this is not true. The technology has severe limitations and drawbacks, which is the reason many manufacturers are looking at other options!
9	p. 18 line 12	"...measured less than 10% capacity loss after 2000 cycles..."	Conditions of cycling must be specified in order to determine relevance and meaningfulness of data for automotive application. Can be very misleading!
10	p.19, lines 3-8	"Existing Definition of Battery Durability and EOL Criteria" In 2010, the German National Platform for Electromobility.... studies on battery durability were given as potential research area but no pressing need for standards on the topic were identified...Even today the European Commission does not have any battery durability in place."	This summarized the current situation, i.e. there is no documented need for durability standard or requirements for xEV.  The following text in this chapter where the authors take on themselves to formulate a "durability" definition is unwarranted and clearly out of the scope and mandate of the prestudy and should be deleted!
11	p.22, lines 1-12	"Electrochemical Degradation Mechanisms of xEV Batteries" ...The various battery components undergo different aging mechanisms; the binder and electrolyte decompose, current collector corrodes, separator melts, cathode undergoes structural disorder and metal dissolution."	The majority of aging mechanisms listed is normal physical and chemical material degradation and are not electrochemical in nature nor driven by electrochemical processes or considerations.
12	p.23, line 8	"Graphite is one of the common anode materials for Li ion batteries operating in organic electrolytes, such as LiPF <sub>6</sub> , with co-solvents like EC, DMC, DEC and EMC"	LiPF <sub>6</sub> is an inorganic conductive salt!  EC, DMC, DEC and EMC are typical organic solvents used in either binary or tertiary mixtures. Co-solvents????
13	p.23, line 4	"Anion contaminants, such as F <sup>-</sup> from	Occurrence of contaminants in the

		HF and PF <sub>5</sub> ...	<p>electrolyte is a cell production quality issue.</p> <p>Surface reactions involving scavenger HF and PF<sub>5</sub> formed during prolonged cycling is mainly an issue for transition metal cathode materials, which can release Mn or other metal cations that can migrate to anode and form metallic clusters on the surface. However, this is mitigated by applying appropriate surface coating on cathodes in the form of basic oxides (such as Al<sub>2</sub>O<sub>3</sub>, MgO, ZnO ZrO<sub>2</sub>). (S F Amalraj <i>et al.</i> in "Electrolytes for Lithium and Lithium-Ion Batteries", T.R. Jow <i>et al. (editors)</i>, Springer (2014) 307).</p>
14	p.23, line 6	"In addition, the dissolution of the cathode electrode...due to disproportionation of Mn <sup>3+</sup> ..."	Only relevant in Mn containing chemistries, i.e. LMO and NMC. Depends on presence of HF contaminants, which is a cell production quality issue.
15	p.23, line 11	" At higher battery potentials,..the graphite oxidizes"	<p>What potentials? Relevance for operating voltage region of automotive Li ion batteries?</p> <p>Issue of inappropriate battery management and not an inevitable condition of Li ion batteries.</p>
16	p.23, line 12	"At this potential, electrolyte co-solvents, such as EC...reacts with the Li ions which leads to growth on the anode surface."	<p>What potentials? Relevance for operating voltage region of automotive Li ion batteries?</p> <p>"Co-solvent" is incorrect terminology.</p> <p>Issue of inappropriate battery management and not an inevitable condition of Li ion batteries.</p>
17	p.23, line 18	Figure 1 shows a typical surface film morphology and cracking of the layer."	<p>Figure reference (Figure 1) is incorrect.</p> <p>Typical morphology for what conditions? Type of cell? Prehistory?b n</p>
18	p.23, line 19	"The formation of this surface film layer is the predominant source of Li ion loss...during storage conditions."	<p>What storage conditions? Time? Temperature? Type of cells? Relevance for xEV application?</p> <p>"Co-solvent" is incorrect terminology.</p>
19	p.23, line 36	"A typical SEM micrograph of anode covered with products of electrolyte decomposition reaction products is shown in Figure 2"	Figure reference (Figure 2) is incorrect.
20	p.23, line 44	"Irreversible Li ion loss is generally attributed to...ii) side reaction of Li ion with decomposed electrolyte compounds and water"	<p>Source of water? Relevance for sealed cells. Humidity control is key production parameter for high quality cells.</p> <p>Impurities of HF and H<sub>2</sub>O occur in trace amounts in electrolytes, but designated HF and H<sub>2</sub>O scavenger additives are used to stabilize the electrolyte and mitigate effects (e.g. aromatic isocyanates) (Wilken <i>et al.</i> in Lithium Batteries – Advanced Technologies</p>

			and Applications, Scrosati <i>et al.</i> (editors), Wiley (2013) 47). Impurity control is a cell production process quality issue.
21	p.24, line 5	“This phenomenon is the main degradation mechanism in fully charged batteries at storage conditions.”	What is “phenomenon” referring to; tunnelling of Li ions or SEI/passive layer growth? Tunneling of ions is extremely unlikely, if even physically possible. What storage conditions? Time? Temperature? What is “fully charged” in this case? Relevance for xEV application? Will xEV cells see the level of charge implied here?
22	p.24, line 9	“The electrolyte additive, VC is one that increases the Li ion loss rate at the anode for Li/coke electrode during storage.”	VC is an essential additive to promote stable SEI layer formation that consumes little Li after many cycles ( <i>Linden’s Handbook of Batteries, 4<sup>th</sup> Ed. (T.B. Reddy (editor), McGraw-Hill (2011) 26.38</i> ). The SEI layer is a prerequisite for electric and safety performance of the graphite anode. Additionally, VC is reported to suppresses PC decomposition in electrolytes containing PC as a carbonate solvent. (K Abe in “Electrolytes for Lithium and Lithium-Ion Batteries”, T.R. Jow <i>et al.</i> (editors), Springer (2014) 172).  “Co-solvent” is incorrect terminology.  Li/coke electrode? Coke is used instead of graphite in cheap consumer type cells and is not a suitable or viable anode material for automotive grade Li ion cells. What is the relevance to xEV application?
23	p.24, line 27	“...electrolyte formulations with high EC content exhibit lithium plating...”	Li precipitates when EC concentration is too high. For this reason, EC concentration in commercial cells is less than 50% (vol) and typically around 30%(vol) where Li solubility is not an issue, even at low temperatures. (M Ue <i>et al.</i> in “Electrolytes for Lithium and Lithium-Ion Batteries”, T.R. Jow <i>et al.</i> (editors), Springer (2014) 97).
24	p.26, Table 5	Effect of electrolyte decomposition are listed as: Loss of <cycleable> Li (i.e. capacity fade) Impedance rise (i.e. power fade)	A more pressing consequence is drying out of the cell. The starved electrolyte designs that predominate in advanced Li ion battery have very small margins for electrolyte loss. Drying out essentially leads to inactivation of parts of the electrodes (ionic conduction is disabled). Minimizing electrolyte amounts is both cost driven, as the electrolyte is an expensive cell component, and driven from safety aspects by reducing the heat release and amount of venting gases in the case of a cell failure.
25	p.26, lines 42-	Sub-heading: “Lithium titanate (LTO)	Inconsistency in report. On page 15, Table 5,

	47		LiTiO <sub>2</sub> is denoted as (LTO). No mention of LiTiO <sub>2</sub> is made on p.26.
26	p.26, lines 42-47	"LTO is inferior to graphite due to its low capacity and high voltage which in turn leads to poor energy density..."	The most important advantages of LTO and why it is considered by several OEMs are missing: <ol style="list-style-type: none"> <li>1) Zero swelling on cycling resulting in superior cycle life due to zero strain on the chemical bonds</li> <li>2) High power capacity due to 3D spinel structure of the crystalline lattice (conductivity limitations of oxides are routinely mitigated by adding carbon black)</li> </ol>
27	p.27, line 17	"LiMn <sub>2</sub> O <sub>4</sub> is noted to have features at high (4.5V) and low voltages (3.3V) which are detrimental to its cyclability"	Are the specified voltages electrode potentials or cell voltages? Relevance to typical operating voltages for xEV?
28	p.27, line 30	"... the usage of this particular composition demonstrates poor performance at high temperature and after storage at low SOC."	What are the specific conditions (temperature, SOC and storage period)? Is this particular composition used in commercial automotive grade batteries? Are the conditions relevant for automotive applications?
29	p.28, line 19	"LAMOF"	Not a generally known material. Commercially used or research material?
30	p.29, line 28	"Exposure to humid air or directly to water affects the purity of the LiFePO <sub>4</sub> material"	Li-ion cells are sealed. Under what conditions can the cathode be directly exposed to humid air or water during normal operation of a vehicle? This is an experimental study condition without relevance for field application of xEV operation.
31	p. 30, line 14	"...capacity fading and increase in impedance by cycling or by aging at elevated temperatures."	What are the specific conditions (temperature, cycling, "aging") and what is the relevance to xEV application? System design of REESS protects the battery/cells from excessive temperatures during normal xEV operation.
32	p. 30, line 46	" The batteries with the SOC of 60, 80 and 100% were stored at 25-55 °C and their impedance was periodically measured. The LiB impedance steadily increased with the storage duration."	Storage period? Relevance for xEV application?  Aging is path dependent and calendar aging is not representative of aging for a battery being used.  SOC based on cell capacity rating or battery/REESS capacity rating. These are not identical and for xEV application and the purpose of a GTR, it is the latter that applies.
33	p. 31, line 17	"A plateau in the high voltage region (>4,5 V vs Li/Li+)..."	Very unlikely electrode potential for NMC electrode during normal operation in xEV since this is way outside normal cut off limits of this chemistry.
34	p.31, line 24	" Structural rearrangements of delithiated NMC have been observed	70 °C is very severe acceleration of aging for current RT battery technology (according to

		after aging at 70 °C for 60 days.”	Arrhenius relationship) and in a temperature region where the risk of unrepresentative chemical reactions and processes are likely to take over. Caution must be exercised when extrapolating results or conclusions to normal operating conditions.
35	s. 31, line 48	“...decrease in capacity of LIB that had been charged to a voltage in excess of 4.2 V (considered here to be an overvoltage).”	Overvoltage is an abusive condition and not representative of normal operating conditions. The accelerated aging effect of abusive conditions are not appropriate for durability performance evaluation and requirements.
36	s. 32, line 1	“ The authors of [61, 62 and 26] showed that the decrease in the capacity of LIB during their cycling could have been caused by the disordering of the layered crystalline structure of LiCoO <sub>2</sub> ...”	The reported effects are obviously obtained on electrodes synthesized in microscale in a laboratory. As stated earlier in the report (p.31 line 49) the capacity fade is strongly dependent on parameters related to synthesis and treatment of material prior to electrode formation. How does automated production in industrial cell manufacturing influence the characteristics and long term durability of the electrode materials? Production parameters control for mass production are notably more stringent than those of manual manufacture of materials in a lab.
37	s. 32, line 13	“In moistened electrolytes, LiPF <sub>6</sub> readily undergoes hydrolysis...”	In sealed Li-ion cells, there is no source of moisture besides trace amount of water (ppm) that are present in the electrolyte at the time of manufacture. Water impurity levels are a cell production quality issue.
38	s. 33, line 1	“ ...at low temperatures the relative resistance and relative capacity of Li-ion batteries show worsening characteristics...”	Reduction in performance at low temperatures (-40 °C) is an inherent characteristic of all chemical systems due to reduced kinetics and rate of reactions. However, operation of a REESS in an xEV is typically controlled by battery management to working temperature window that is not to be confused by the ambient temperature. Hence, the relevance of the low temperature data presented is questionable. ICE vehicles have similar problems starting at extreme cold temperatures, so not unique for xEV operation.
39	s.33, line 18 ff	“The stability of negative electrodes is also negatively affected by the LIB storage at temperatures in excess of 40 °C.”	How likely is prolonged storage at temperatures > 40 °C in xEV application? First the mass effect of the REESS significantly influence the rate that the battery heats up and the temperatures reached within reasonable time periods (e.g. parking). Secondly, the battery is not directly exposed to a heating source, there is constructional shielding, which will also effect heating rates and the expected

			temperatures reached. Exposure to extreme temperatures > 60-70 °C results in onset of chemical reactions and processes that are not typical of representative of normal operating conditions, and
40	p.35, line 27	“Cycling at two different rates, C/2 (fast) and C/5 (slow) was performed”	Constant current cycling is not representative of vehicle operation. End points for discharge and charge important for total cycle life, especially the extreme SOC (SOC>90% and SOC<10% based on cell rating). Since aging is path dependent, great caution has to be exercised when attempting to extrapolate observations from highly idealized studies on half-cells i a simplified electrolyte environment and non-representative electrical performance conditions. LiCoO <sub>2</sub> is not a preferred Li ion cell chemistry for automotive application.
41	p.37, line 11	“After cycling, at C/5 to the designated number of cycles... the full cells were disassembled. The cycled LiCoO <sub>2</sub> electrodes were rinsed...”	Recent research show that the electrode morphology changes when the cell is opened, exposed to air and rinsed. Difficult to quantify how test method affects capacity fade measurements. (S. Malmgren (2013) PhD thesis, Uppsala Univ.)
42	p.38, line 15 ff	“A study was performed to assess the effect of the charging protocol on the cycle life of a commercial 18650 Li ion cell ...”	Cell design and size impacts on current/voltage distribution functions, mechanical stress, thermal conditions and gradients, etc. How does cycling in 18650 cylindrical cell compare to charging in a stacked prismatic cell? Would prismatic? Pouch?
43	p.38, line 17	“Fast charging resulted in an accelerated capacity fading...”	Definition of “fast charge”? 0,5C used in study not necessarily “fast”. Depends on cell design and specification
44	p.39 , line 1	“From the results of this work, it may be concluded that cycle life of Li ion cells is significantly affected by the charging protocol even if the same charging rate is applied.”	Hence charging is customized as per manufacturer’s specification. Results from stereotypical laboratory cycling may show misleading results and can be used for qualitative discussions but have very limited value for quantitative lifetime predictions.
45	p.40, line 11	LiNi <sub>0.8</sub> Co <sub>0.15</sub> Al <sub>0.05</sub> ...were cycled over 100% DOD at RT and 60 °C to investigate the effect of high temperature degradation mechanisms	Relevance for xEV?
46	p.40, line 26	“Effect of Overcharging and Overdischarging”	Both these conditions are abusive! Not representative of normal vehicle operation and not suitable for durability regulation. Assumes malfunctioning BMS. (see p.41 lines 34-40)
47	p.23-44	“Electrochemical Degradation Mechanisms of xEV Batteries” Entire chapter	General comments on this chapter: The passive/SEI layer formation described in multiple places under different sub-headings in this chapter is in fact the very same layer.

			<p>The SEI layer on the anode is essential and a prerequisite for sound and safe Li ion battery performance, as it prevents parasitic reactions and decomposition of the electrolyte due to the instability of the organic solution in contact with graphite. The SEI layer will continue to grow after formation, but at a low rate.</p> <p>The current description ignores the importance of the SEI for battery life and performance.</p> <p>The layout of the text is confusing as it requires substantial insight to realize that the “passive layer” and the “SEI layer” are one and the same. Whereas there are several parameters that may affect subsequent rate of growth and the physical/chemical characteristics of the anode surface layer, it is there for a reason, and cell durability and overall performance would be severely reduced if it was missing.</p> <p>The studies referenced in this chapter are very academic in nature and typically performed as material investigations on half-cells or (at best) on laboratory prototype microcells. There is no discussion about how these phenomenological investigations translate into processes in commercial automotive cells as part of an xEV REESS design. Up-scaling effects at cell level, cell design parameters (mechanical) as well as material/chemical optimization of the electroactive components (anode, cathode, electrolyte), system design, operating parameters and battery management for the application all have huge impact on battery life and performance. The application and system parameters, as well as the cell parameters, determine which of the possible aging mechanisms that can possibly come into play for xEV battery design and usage. This analysis is missing in the report which is remarkable, since it is the life expectancy in xEV application which is the topic and the area of concern for the prestudy!</p> <p>What is the intent of the literature summary? For example, a possible/likely consequence of durability regulation would be to encourage automotive manufacturers to disable fast charging, as this has several elements that promotes accelerated aging of the battery cell. Is this a desirable effect?,</p>
48	p.47, line 22	“Under uncontrolled charging, the EV	Define “uncontrolled charging”?



		is charged up to 80% SOC..."	Uncontrolled charging may be an abusive condition, as BMS functionality includes charging control!
49	p.48, Table 8		Data appears to assume linear degradation of capacity with cycles and calendar life. Towards EOL, degradation is not linear; caution with extrapolation of results is recommended.
50	p.49-50	Charging studies of PHEV and BEV	Reasoning leading up to charging patterns assumes that the driving distance and behavior is fully predictable and leaves no room for improvisation. Road blocks, detours, or unforeseen errands can severely impact on the driving experience in real life. How realistic that an average user is willing to plan travel logistics at this level of detail?
51	p.51, line 6	"A study by Krieger presents a comparixon of lead-acid, LCO-NMC, LCO and LFP cell degradation whne charged with a wind-based current profile.."	Cell/battery design and optimization for EV and renewable energy application are not the same. Application optimization impacts on battery performance and life under given conditions. Cannot assume that weaknesses of batteries for stationary applications are the same as for automotive batteries.
52	p.58, line 2	"Therefore part of a worst-case durability testing procedure should combine high SOC with high temperature in order to observe faster degradation"	The weakness of any accelerated test method is ensuring practical relevance. When determining "worst case" it is necessary to weigh in likelihood of occurrence. Consideration of geographical relevance may be needed when developing an international regulation in order for test method to be representative of conditions the vehicle can experience during a life time.
53	p.58, line 6	"Worst case PHEV driving and charging patterns are those with high utilization of charge depletion mode of operation."	A realistic durability procedure should consider a mix of "average" and worst-case operation.
54	p.59, line 1	"Song <i>et al.</i> examined the impact of pre-heating a battery in low temperature climates on the performance and lifetime of the battery..."	What is the effect of heating/cooling protocols for preconditioning of batteries on the total energy consumption/energy impact of the vehicle? Measures to prolong battery life must be justified in terms of overall energy footprint.
55	p.61, line 11	"Conclusions drawn suggested that thermal management increases life by 5% or 53%, depending on the scenario..."	Thermal control is a basic feature of any automotive BMS!!!
56	p.62, line 4	"Battery aging is caused by multiple phenomena related to both cycling and time. Battery degradation is accelerated with DOD and frequency of cycling, elevated temperature and elevated voltage exposure, among other factors....the observable effects of degradation are an increase in resistance and a reduction in	Temperature and voltage exposure are controlled by BMS function and designed to protect the battery from accelerated aging.  Extreme temperatures and voltages are considered abusive conditions and should not form grounds for durability requirements.

		capacity”	
57	p.66, line 4	“Takei <i>et al.</i> performed an experimental investigation into commercial 1,25 Ah 18650 LiCoO <sub>2</sub> /hard carbon cells for an accelerated aging study.”	<p>Paragraph is incomplete; operating conditions and results are missing from the report.</p> <p>Commercial 1,25 Ah 18650 LiCoO<sub>2</sub>/hard carbon cells are not typical cells for xEV application. Cell size and design is particularly important for thermal evolution and conduction within and out from the cell. Modern xEV cells are ranging from 10-60 Ah. Data measured on large-scale cells are generally missing in the report. Analysis of impact of geometric dimensions, casing materials, and type of cell is also missing. Analysis of the importance and effect of basic system design factors (e.g. Coulombic and thermal management ) that are inherent to xEV batteries is missing.</p> <p>There is nothing in the report substantiating that regulation on durability/performance is required since normal battery design and system control that are in place effectively limit the impact of all aging factors listed and considered in this report.</p>
58	p.66, line 35	“The authors estimate that the extra battery capacity required for an 80% vs 94% DOD window will lead to a 2800 USD increase in pack cost.”	<p>Regulating durability and performance is going to be cost driving, which means it will affect the industry’s possibility to reach politically driven cost targets for the technology in short- to mid-term perspective. Must be considered in the justification of developing a durability GTR.</p>
59	p.67, line 6	“In the case of cycling at 0 °C to -10 °C, however, capacity fade is linear up to cycle 300...”	<p>Ambient temperature and battery temperature are not the same. BMS will regulate temperature to appropriate levels for vehicle performance. Sub-zero operation is not likely to occur to any significant extent.</p> <p>Cycling is not defined. However, data indicates that constant current 1C cycling is inferred over the entire SOC window based on cell rating. Cycling conditions are not representative of normal vehicle operation. Standards typically use CC cycling as this allows qualitative comparisons during the development phase. However, this is different to normal operating conditions and hence not recommended for a durability GTR.</p>
60	p.72, line 14	“These simulations assume that calendar life degradation in practice is insignificantly different from calendar life degradation in the laboratory, that module-level performance	<p>What is the justification for assuming that the rate of battery degradation is independent of control strategy? All studies cited show that the control strategy is fundamental for battery life; e.g. charging protocol, thermal</p>

		degradation dominates over pack level effects such as module imbalance and that the rate of battery degradation is independent of control strategy.	management, Depth of discharge, etc, impact on battery life expectancy
61	p.76, line 11	Case study of 2012 Chevrolet Volt (PHEV)	Testing is performed on single test vehicle. No reference or comparison is made to other vehicles in Table 16. How significant (what is the confidence) in the Chevy Volt data?
62	p.79, line 4	“Some of the existing standards and test procedures that we shall investigate are SAE J2464, ISO 12405-1/2, UN 38.3, ...	SAE J2464 is an abuse (safety performance) evaluation standard. Not relevant for durability evaluation. UN 38.3 is a test protocol for evaluating abuse conditions that can occur during transportation (Transportation of Dangerous Goods) and has no relevance for durability studies.  ISO and FreedomCar standards are intended for product development testing and are not necessarily representative of vehicle field usage conditions. Development tests typically explore wider ranges of parameters than what is used in the final application.
63	p.81, line 8	“One set of standard which may not have been considered for commercial electric vehicle applications are those from the US Department of Defence, specifically for Group 31 and Group 34 lithium ion batteries. These feature a range of performance and environmental tests which may be useful for determining some standards for xEV testing. Some of the specified tests are: 1. Deep cycling... 2. High Temperature Cycle Life... 3. Battery Storage and charge retention ... 4. Calendar life...”	Do these tests constitute a proposal for tests to be used to evaluate Durability?  What is the experience of these tests from US DoD? How accurate/useful are the tests and criteria to predict performance life?  Relevance of tests and test parameters for xEV application?
64	p.81-83	Lists of tests from various standards	What is the intent of this list? Several tests are well-known safety/abuse tests. Why included in this report? Abuse/safety is the focus of IWG EVS and should not be considered by IWG EVE.
65	p.84, line 14	“Cycle Life TeSting” “The number of cycles specified for PHEV and BEV EOL is 1000...”	Not meaningful to define number of cycles without defining <b>what</b> cycles. CC cycling is not representative of vehicle application. Application specific drive cycles are likely to more accurately represent actual use. Thermal management of REESS will

			<p>mitigate effect of ambient temperature during cycling as the battery will have its own "climate". What is justification for life cycling at different temperatures from -10 to +35 °C, if the cells inside the battery will never experience these temperatures? What is specifically being addressed by this test procedure?</p> <p>Terminology for fast and slow charging is not clear. If durability becomes an issue, then fast charging may not be an option for the vehicle.</p>
66	p.84, line 33	Calendar life testing	<p>Is calendar life testing significant for vehicles? Previous literature review suggests that calendar aging is insignificant compared to other aging processes in xEV (See p.72, where calendar life is assumed insignificant in model assessment of USABC battery testing standard. Despite this, USABC underestimates performance life!) A logical conclusion is that calendar life is not necessary for durability determination.</p>
67	p.84, line 39	<p>"Additional Environmental Considerations for Testing" Reference to MIL-STD environmental exposure tests</p>	<p>Need to consider realistic sensitivity/exposure of critical parts of the REESS to the listed conditions and the purpose of the test:</p> <ol style="list-style-type: none"> <li>1) Humidity – covered by water resistance test in GTR-EVS?</li> <li>2) Salt spray</li> <li>3) Sand/dust</li> </ol> <p>Assuming test on vehicle level.</p>