Delivered via Electronic Mail

October 1, 2021

Mr. Michael McCarthy
Chief Technology Officer
Air Resources Board
1001 I Street
Sacramento, CA 95814

Subject: Advanced Clean Cars 2 Battery Durability and Warranty

Dear Mr. McCarthy,

The Alliance for Automotive Innovation (Auto Innovators)[1] appreciates the opportunity to provide comments on the California Air Resources Board's (ARB) Advanced Clean Cars 2 (ACC 2) regulatory proposals. Specifically, this letter provides some background and our recommendations on the Advanced Clean Cars 2 (ACC 2) proposed changes to ZEV and TZEV durability and warranty provisions.

Introduction

As we find ourselves on the cusp of broad EV deployment, the automotive industry has been working diligently with government and relevant stakeholders to drive the regulatory landscape of the future. For the past two years, Auto Innovators, its predecessor organizations, and automakers around the world have spent countless hours working with our government partners at EPA, the European Commission, and METI as a part of a United Nations workgroup to develop a robust and globally accepted EV battery durability requirement.

As a result of this work, the United Nations Economic Council of Europe (UNECE) Electric Vehicles & the Environment (EVE) Informal Workgroup (IWG) has developed a consensus spanning multiple

[1] Formed in 2020, the Alliance for Automotive Innovation is the singular, authoritative and respected voice of the automotive industry. Focused on creating a safe and transformative path for sustainable industry growth, the Alliance for Automotive Innovation represents the manufacturers producing nearly 99 percent of cars and light trucks sold in the U.S. The organization, a combination of the Association of Global Automakers and the Alliance of Automobile Manufacturers, is directly involved in regulatory and policy matters impacting the light-duty vehicle market across the country. Members include motor vehicle manufacturers, original equipment suppliers, technology and other automotive-related companies and trade associations. The Alliance for Automotive Innovation is headquartered in Washington, DC, with offices in Detroit, MI and Sacramento, CA. For more information, visit our website http://www.autosinnovate.org.

continents on the appropriate requirements for EV traction battery durability, which is being finalized in a Global Technical Regulation (GTR). Phase 1 of the workgroup's negotiations developed an agreement to establish Usable Battery Energy (UBE) as the preferred metric to measure traction battery State of Health (SOH). In early discussions within the workgroup, establishing "range" as the preferred metric for SOH was first considered. However, due to the many external influences that contribute to accurately measuring range, the workgroup agreed to reconsider range as a metric in Phase 2 of the GTR, as more supporting data is gathered in Phase 1.

In addition to establishing appropriate methods to measure SOH, the workgroup has agreed on specific minimum performance requirements (MPR) for EV batteries. The current GTR establishes an MPR that batteries must maintain at least 80% SOH after 5 years or 100,000km (62,000mi) and/or 70% SOH after 8 years or 160,000km (100,000mi).[2] These requirements were developed by considering the current and anticipated technological capabilities of traction Li-Ion batteries, while still balancing the reliability needs of the consumer. Auto Innovators and its members consider this MPR to be a challenging, yet realistic requirement considering what is feasible today.

Auto Innovators and its members have been active supporters of the UNECE's GTR established by the IWG. This letter explains our position as it relates to CARB's current battery durability proposal under the ACC 2 rulemaking.[3] We firmly believe that adopting the UNECE's GTR is the best path forward to accelerate EV adoption, lower emissions, and reduce fossil fuel dependence. Establishing overly stringent requirements may have negative environmental consequences and raise the costs for both manufacturers and consumers. Maximizing EV consumer options and reducing regulatory complexity will help to prevent those issues and further progress EV adoption globally.

Background

Beginning in early 2017, the UNECE workgroup began considering the topic of battery durability. Members of the workgroup presented numerous potential approaches to developing a robust and globally accepted battery durability standard. Throughout this process, areas of discussion included the development of durability test procedures, how to identify default deterioration factors (DFs), and the proper testing procedures of aged or age-emulated batteries.

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[2] Electric Vehicles and the Environment (EVE) Informal Workgroup (IWG), United Nations Economic Commission for Europe (UNECE). "Draft GTR EVE #52," September 8, 2021.

[3] California Air Resources Board, Advanced Clean Cars (ACC) II Workshop (May 6, 2021), at 79, *available at* https://ww2.arb.ca.gov/sites/default/files/2021-05/acc2_workshop_slides_may062021_ac.pdf.

Since then, the UNECE workgroup spent over four years developing the GTR framework that we have today. Throughout this process, numerous scenarios and approaches were considered, including the approach being considered by CARB.

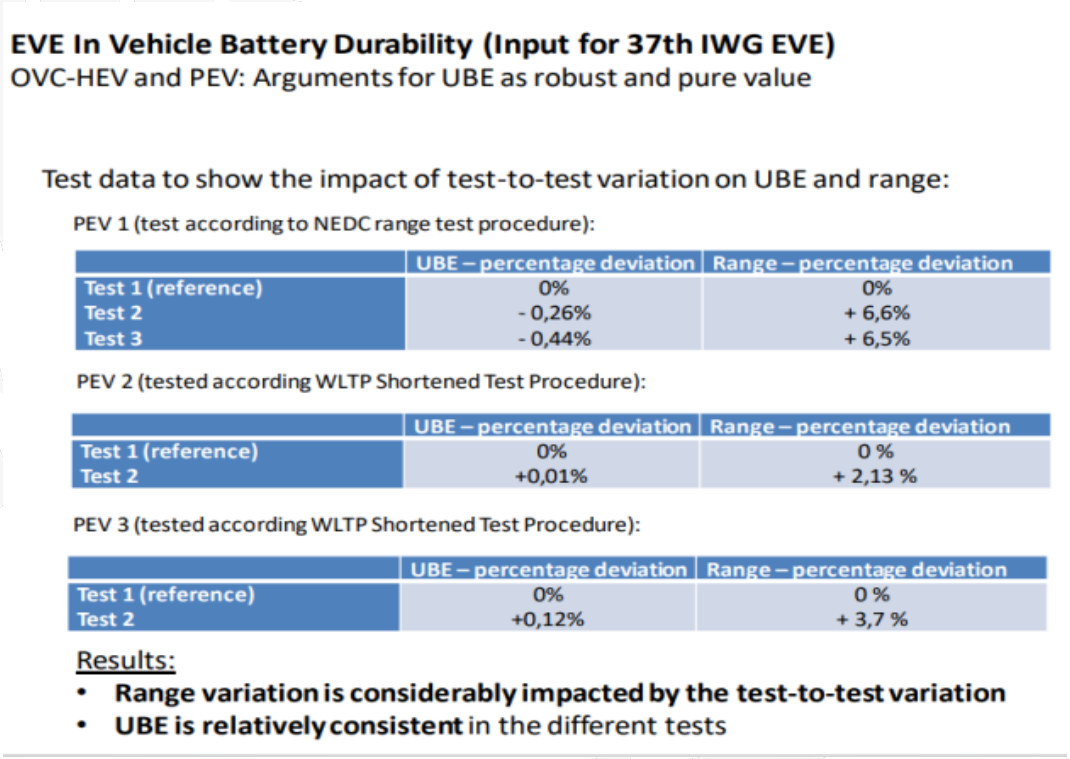
Throughout the initial stages of the GTR development, the UNECE workgroup planned to use range as a SOH measurement by looking at both the internal and ambient factors that play a role in battery degradation. Throughout its lifespan, a battery will experience repeated hardships due to external temperatures, driving style, failure of other external components, etc. Therefore, it would seem as if the correct approach in measuring the SOH of a traction battery would be to take into consideration all factors that affect battery health. However, the reasons this strategy makes sense in concept are the same reasons the decision was eventually made to focus solely on the battery itself when determining its SOH; there are too many uncertain and variable factors that influence the degradation of range to achieve an accurate and universal range measurement for a vehicle. For an example, an EV used in Kansas will not experience the same hardships as a car used in a mountainous environment such as Colorado or Wyoming. Damaged parts such as broken wheel bearings from poor road conditions could cause strain on the battery by requiring more energy to compensate for the broken part. Defective aerodynamic accessories could also create strain on the battery due to an increased drag coefficient.

Members of the workgroup attempted to develop a scientific model to measure battery SOH using range as the measurement. Due to technological and data limitations, calculation of a range measurement is not feasible today. As a result of the current limitations for range measurement, the workgroup agreed to reconsider range measurement during Phase 2 of the GTR. By postponing the implementation of a range requirement, manufacturers and the relevant government agencies will be able to compile the data produced by the Phase 1 testing and determine if a range-based requirement is needed and, if needed, what that requirement should be.

Instead of focusing on external factors outside of the battery, the calculation of a battery SOH based on UBE focuses solely on the battery itself. As a result of the singular focus on the battery, the workgroup agreed that it is possible to define tolerance and durability requirements for the battery SOH using UBE as its metric, which is not possible for range. We strongly recommend that CARB adopt the same approach of using UBE for the determination of SOH.

The UN workgroup has spent years deliberating the development of a battery durability GTR. The workgroup contains members that span across half a dozen countries across the globe and includes both government and industry experts in this field with extensive knowledge in the battery sphere. The workgroup has been chaired by a representative from the United States Environmental Protection Agency throughout its lifespan. As chair of this workgroup, EPA has overseen the development of this GTR and has agreed to move forward with UBE as the SOH metric for Phase 1 to set durability requirements. It is currently the opinion of the workgroup that this is the best path forward to advance

and modernize the regulatory landscape, as well as foster the best environment for EV adoption moving forward. As a result of the global cooperation and efforts of the IWG, the workgroup has developed a robust framework for measuring SOH that is scalable to every market. Vehicles are produced for multiple markets and must adhere to a multitude of regulations that can vary by region and country. Adoption of a globally accepted GTR for SOH in CARB's ACC 2 rulemaking would reduce uncertainty associated with measuring range in-use and would harmonize California's requirements with others. As a result of this harmonization, vehicle production costs may decrease, making electric vehicles more accessible to people of all socio-economic backgrounds, for both new and used purchasers.



EVE In Vehicle Battery Durability (Input for 37th IWG EVE)

OVC-HEV and PEV: Arguments for UBE as robust and pure value

Test data to show the impact of test-to-test variation on UBE and range:

PEV 1 (test according to NEDC range test procedure):

	UBE – percentage deviation	Range – percentage deviation
Test 1 (reference)	0%	0%
Test 2	- 0,26%	+ 6,6%
Test 3	- 0,44%	+ 6,5%

PEV 2 (tested according WLTP Shortened Test Procedure):

	UBE – percentage deviation	Range – percentage deviation
Test 1 (reference)	0%	0 %
Test 2	+0,01%	+ 2,13 %

PEV 3 (tested according WLTP Shortened Test Procedure):

	UBE – percentage deviation	Range – percentage deviation
Test 1 (reference)	0%	0 %
Test 2	+0,12%	+ 3,7 %

Results:

- **Range variation is considerably impacted by the test-to-test variation**
- **UBE is relatively consistent** in the different tests

Figure 1. *Source: Stellantis data modeling. Additional information available upon request.*

Figure 1 shows the consistency of the UBE measurement when compared to the test-to-test variation of both UBE and range. These data points served as supporting evidence when determining the appropriate measurement for battery durability throughout the GTR process.

Technical justification for GTR standards

For nearly two decades, automotive battery technology has advanced at a rapid rate. However, despite the revolutionary progress that has been achieved over the past twenty years, battery technology cannot yet achieve the standards proposed under ACC 2. The members of the UN workgroup have

decades of combined experience in the EV battery field. Many members are among the first engineers to successfully develop and implement these modern batteries into automobiles. Today those same engineers are on the forefront of battery technology development and have concluded that the batteries on the market today are not capable of reaching the standards proposed by CARB.

Today, the price of electric vehicles is higher than conventional internal combustion engine cars. To date, production costs of batteries continue to create a premium on these vehicles, which may act as a barrier to broader EV adoption for certain demographics. The implementation of CARB's proposal may further increase the price in an attempt to achieve these particularly stringent standards. Compared to the GTR, CARB's proposed standards are 1.7x (based on the time requirement) and 1.7x more stringent (based on the distance travelled requirement).

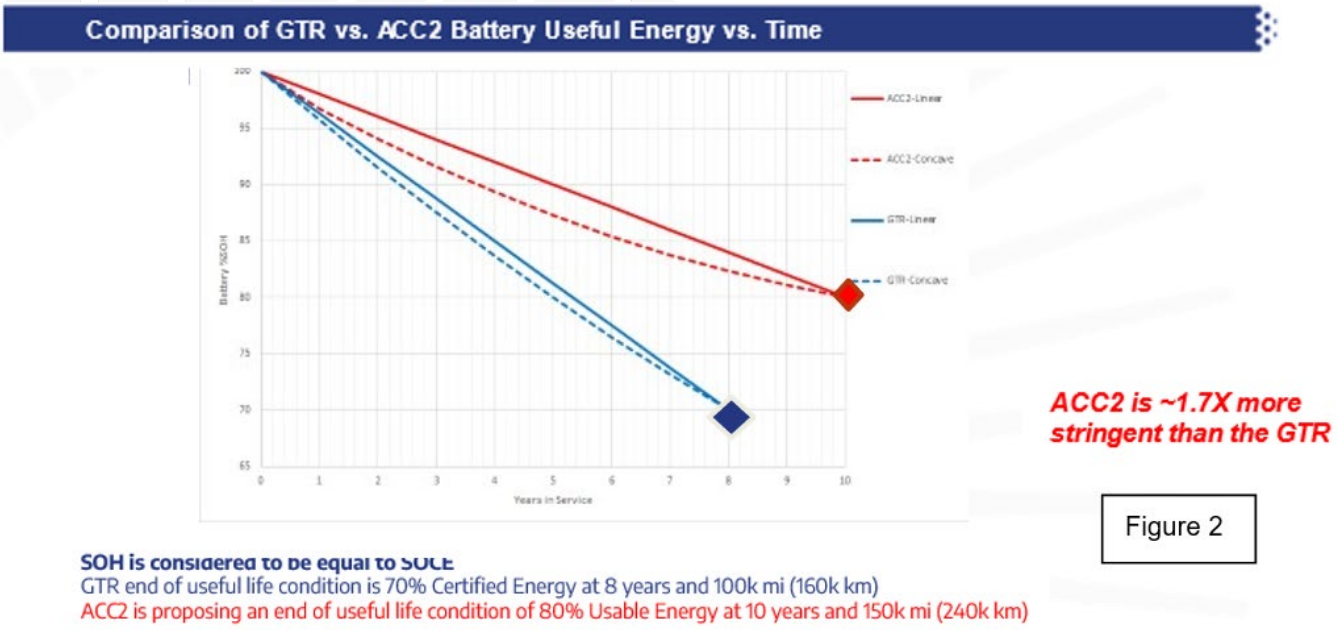


Figure 2. *Source: Stellantis data modeling. Additional information available upon request.*

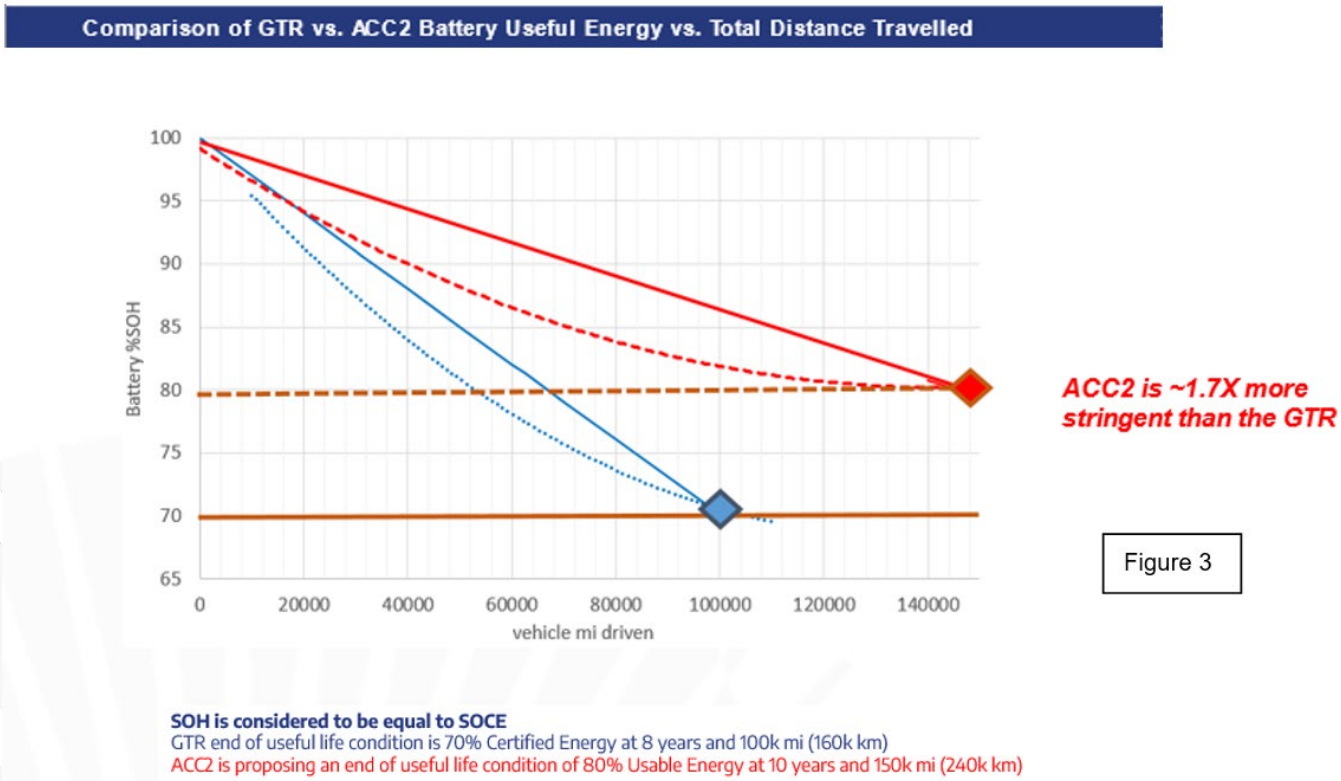


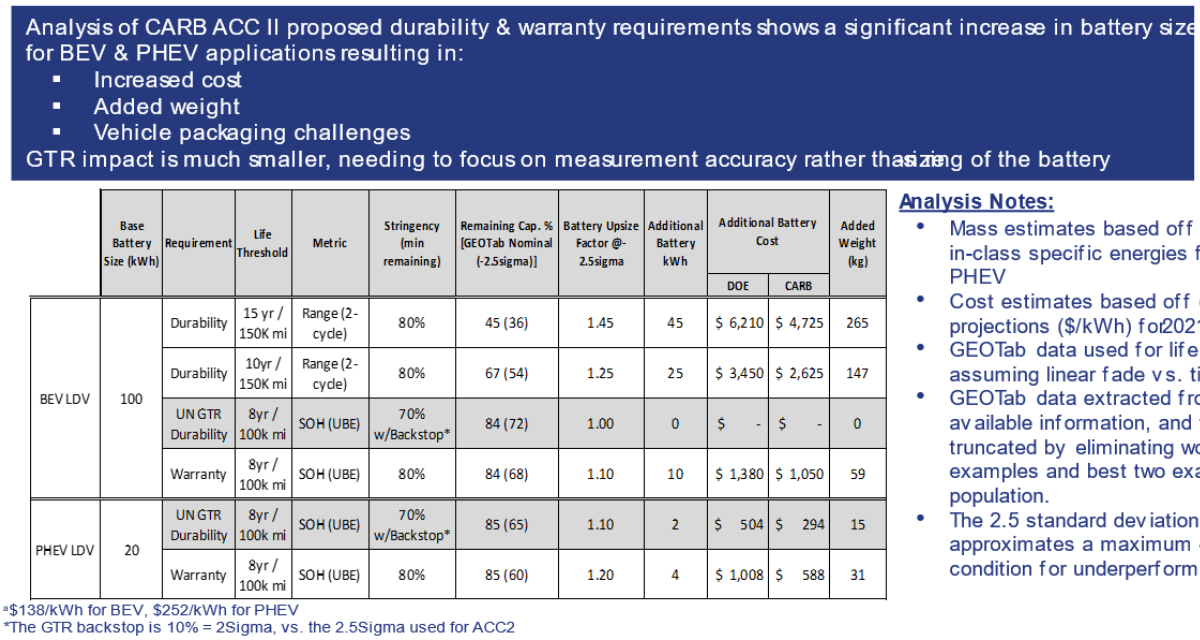
Figure 3. *Source: Stellantis data modeling. Additional information available upon request.*

While fade is often idealized to be linear over both time and distance traveled (total battery energy throughput), various battery technologies can deviate from linearity, offering a more curved/concave profile, as is seen in the Figures above. As a result, battery technology improvements balance life with higher priority improvements of cost, fast charging, and energy density.

Benefits to the Consumer

As the automotive landscape experiences one of its biggest changes since the inception of the car, we are working to ensure that clean and zero emission vehicles become accessible to all people and develop a robust and reliable second-hand market. CARB has made clear that it is also a strong supporter of equity within the automotive industry. The use of battery durability standards is a great way to ensure that a vehicle's traction battery will be able to survive at an operational level throughout the life of the automobile. In theory, this dependability will drive down costs of new vehicles, as well as produce a rich market of second-hand EVs, making them even more accessible for lower-income customers. However, the standards proposed by CARB will have the opposite effect of what we are both trying to accomplish.

Imposing a 10-year/150,000mi standard on all EV traction batteries will have numerous consequences that will hinder the EV adoption progress already made thus far. EPA and other global regulators have concluded that more time is needed to develop robust durability requirements for range. As was recognized by the IWG, postponing the consideration of a range requirement until Phase 2 of the GTR in favor of a UBE metric is the right path forward. This allows the workgroup and regulatory bodies to gather and analyze sufficient data from Phase 1 to better help establish an appropriate battery durability standard moving forward. We strongly recommend that CARB adopt this strategy.



Analysis of CARB ACC II proposed durability & warranty requirements shows a significant increase in battery size for BEV & PHEV applications resulting in:

- Increased cost
- Added weight
- Vehicle packaging challenges

GTR impact is much smaller, needing to focus on measurement accuracy rather than sizing of the battery

	Base Battery Size (kWh)	Requirement	Life Threshold	Metric	Stringency (min remaining)	Remaining Cap. % [GEOTab Nominal (-2.5sigma)]	Battery Upsize Factor @-2.5sigma	Additional Battery kWh	Additional Battery Cost		Added Weight (kg)
									DOE	CARB	
BEV LDV	100	Durability	15 yr / 150K mi	Range (2-cycle)	80%	45 (36)	1.45	45	$ 6,210	$ 4,725	265
		Durability	10yr / 150K mi	Range (2-cycle)	80%	67 (54)	1.25	25	$ 3,450	$ 2,625	147
		UN GTR Durability	8yr / 100k mi	SOH (UBE)	70% w/Backstop*	84 (72)	1.00	0	$ -	$ -	0
		Warranty	8yr / 100k mi	SOH (UBE)	80%	84 (68)	1.10	10	$ 1,380	$ 1,050	59
PHEV LDV	20	UN GTR Durability	8yr / 100k mi	SOH (UBE)	70% w/Backstop*	85 (65)	1.10	2	$ 504	$ 294	15
		Warranty	8yr / 100k mi	SOH (UBE)	80%	85 (60)	1.20	4	$ 1,008	$ 588	31

[a]$138/kWh for BEV, $252/kWh for PHEV
*The GTR backstop is 10% = 2Sigma, vs. the 2.5Sigma used for ACC2

Analysis Notes:

- Mass estimates based off typical best in-class specific energies for BEV and PHEV
- Cost estimates based off of DOE cost projections ($/kWh) for 2021-2022[a].
- GEOTab data used for life projections, assuming linear fade vs. time.
- GEOTab data extracted from publically available information, and then truncated by eliminating worst two examples and best two examples from population.
- The 2.5 standard deviation (Sigma) limit approximates a maximum 4% warranty condition for underperforming product.

Figure 3. *Source: Stellantis data modeling. Additional information available upon request.*

Auto manufacturers would likely add additional battery capacity to the vehicle platform and/or electronically limit the useable energy capacity to achieve the requirements proposed by CARB. The addition of the extra battery capacity or limitations to usable energy capacity would have negative consequences that impact consumers. As seen in the table above, adding additional batteries increases the overall weight of the vehicle, which in turn makes the vehicle less efficient and requires a higher energy output from the batteries. The addition of these extra batteries results in higher production costs of the vehicle itself, which are eventually passed down to the consumer. Based on the 80% of 2-cycle range for 10 years/150,000 proposal with a standard 100kWh battery, manufacturers would expect on average a $2,625 to $3,450 increase in 2022MY production costs to their new BEVs, as well as a 147kg weight increase in order to accommodate the proposed standards. Increasing the price of these vehicles further limits customer acceptance.

Additionally, we would like to propose an alignment of the metric used to evaluate both the durability requirement and the warranty proposal developed by CARB. As it stands now under ACC 2, battery durability is measured through a range requirement in miles. Conversely, warranty is measured through a battery capacity or SOH metric. We firmly believe that SOH is an appropriate and reliable metric for warranty, that the same can be said for measuring durability. Therefore, we further emphasize our preference for SOH to be the measurement for both durability and warranty.

Warranty

We agree with using the consumer accessible SOH for the warranty metric, but recommend allowing the OEM to specify their warranty thresholds as CARB originally proposal for ACC 2. Unlike emission-related parts, where failure can increase emissions, a BEV with a 77% SOH cannot have higher emissions than a BEV with a 93% SOH. Moreover, warranties are inherently competitive and have been since their inception. We respectfully request that CARB maintain that competitiveness and uphold their original proposal.

Backstop

Throughout this letter we have adamantly expressed our desire to harmonize with the UNECE GTR as it pertains to battery durability. We believe that UBE is the best metric to measure durability for the future of EVs. However, if CARB chooses to continue to use range as their preferred metric, we would like to respectfully request that a range backstop be established under the ACC 2 durability proposal.

Batteries and battery chemistry can vary by OEM, vehicle model, and vehicle model year. Different cars are made for different purposes and customers use them in different ways to suit their lifestyle. We support CARB's mission to increase EV access to all demographics; however, establishing a blanket threshold of 80% across all EVs can have negative consequences for EV adoption.

For an example, an EV that started with a 300+ mile range that has degraded to 53% (well below the proposed 80%) after 10 years to a 160-mile range still has a reliable useful life remaining. There is a substantial market for EVs that have a 160-200 mile range, especially for customers living in urban environments. Recalling a 300-mile EV that has degraded to a range of 239 miles (just below the 80% threshold) is detrimental to the overall acceptance and adoption of EVs. That is why we propose to establish a 160-mile range backstop after 10 years/150,000 miles. Establishing this backstop will prevent unnecessary recalls and keep EVs on the road for longer, which in turn will lower the overall cost of EVs.

Conclusion

The United States is a signatory of the 1998 UN agreement that created the venue in which nations negotiate and develop international Global Technical Regulations. Parties to the agreement understood the broad value of establishing global standards that are consistent across the world's markets to help facilitate deployment of cutting-edge technologies like electric vehicles. Uniform international regulations drive investment at greater scale than would be achieved with a patchwork of national (or sub-national) rules. Furthermore, international regulations are a recognized tool that accelerate innovation by giving researchers and manufacturers a common, level playing field for their products to compete.

Auto Innovators recognizes the leadership role California has played in helping to drive electric vehicle commercialization and focusing on battery durability to protect consumers and build confidence in the EV market. Auto Innovators and its members are aligned with those policy objectives and each member has devoted significant technical research, together with battery suppliers, to continuously advance the capabilities and longevity of cell chemistry. As we are in a period of accelerating innovation, our members have been active participants in the GTR workgroup and are confident that the initial phase of this GTR appropriately balances consumer protection and innovation. We thank CARB for this opportunity to provide insight on this proposal and look forward to our continuing partnership on these issues.

Sincerely,

Michael Watson

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