

Report of the 69th session
Electric Vehicles and the Environment Informal Working Group (EVE IWG)

Location: The K-Hotel Seoul
(06769) 70, Baumoe-ro 12-gil,
Seocho-gu, Seoul,
South Korea

Date: April 16 – 17, 2024

Time: 09:00 – 05:00 KST

Chairs: Mr. Michael Olechiw (United States of America)
Ms. Elena Paffumi (European Commission)

Vice-Chairs: Ms. Chen Chunmei (China)
Mr. Nobunori Okui (Japan)

Secretariat: Mr. Leeson Guay (Canada)

Day 1 – April 16, 2024, 09:00 KST

1. Introduction and review of agenda

Documentation

- EVE-68-12e
- EVE-69-02e

Context

The EVE IWG co-chairs addressed members and welcomed everyone to the virtual meeting.

The co-chairs presented the meeting agenda to EVE IWG members, which can be seen below. The agenda was reviewed and adopted by the EVE IWG prior to beginning discussions. Modifications to the agenda occurred and have been reflected in EVE-69-19e.

Day 1 – April 16, 2024, 09:00 KST

- Introduction, review of agenda, meeting recap
- HDV GTR – Review of open items
- HDV GTR – MPR and metric proposal

- HDV GTR – Comments on working draft feasibility
- HDV GTR – Comments and open item positions
- HDV GTR – OICA position and comments on draft text
- HDV GTR – Metric and minimum performance requirements
- HDV GTR – Test procedure steps and boundary conditions
 - o *Temperature method 1a & b*
 - o *Test steps and family concept*
 - o *Break-off criterion*
 - o *Driver breaks*
 - o *REESS measurement vs. onboard data*
 - o *Alternative methods*

Day 2 – April 17, 2024, 09:00 KST

- Introduction, review of agenda
- UN GTR 21 – Revised proposed plan
- UN GTR 22 – Use of simulations for driving ranges of BEVs
- UN GTR 22 – Results of Korean research pre-test
- UN GTR 22 – Korean EV battery regulation
- UN GTR 22 – Position on work planning
- UN GTR 22 – Part C family comments
- Overview of Euro 7
- Swappable battery durability GTR proposal
- HDV GTR – Review of draft text
- Future planning and logistics
- Closing remarks

The EVE IWG secretary briefly reviewed the *Report of the 68th EVE IWG session*, highlighting action items and key decisions from the discussions, held virtually, on February 28-29, 2024.

Discussion

The co-chairs thanked the Korean delegation for welcoming the EVE IWG to Seoul, South Korea. The Korean delegation responded that it is an honour and privilege to be able to host this event.

The Korean delegation outlined some meeting logistical information including location of bathrooms, lunch planning and emergency evacuation procedures.

The co-chairs requested the secretariat to modify the agenda to have light-duty vehicle (LDV) topics take place first on day two, starting with UN GTR 21 topics.

Action Items

- Secretariat to modify the day 2 agenda to include LDV topics occurring first, starting with UN GTR 21 topics.

Decisions

2. HDV GTR – Review of open items

Documentation

- EVE-69-07e

Context

This item was set with the objective of continuing discussions on the draft United Nations Global Technical Regulation (UN GTR) on battery performance and durability of electrified heavy-duty vehicles (eHDV).

The drafting coordinator offered a quick introductory presentation on where everything stands with regards to the draft text and topics that remain outstanding.

Discussion

The drafting coordinator expressed that there was significant feedback received on the draft text and that work has started to try and incorporate all this feedback into the draft text. Work is still in progress but once fully updated, the latest draft text will be posted to the wiki page for the EVE IWG.

Action items

- The drafting coordinator to update the eHDV GTR draft text to incorporate all feedback received to date.
- The drafting coordinator to send the latest version of the eHDV GTR draft text to the EVE secretariat for uploading to the wiki page.

Decisions

3. HDV GTR – MPR and metric proposal

Documentation

- EVE-69-10e
- EVE-69-21e
- EVE-69-23e

Context

The Chinese delegation offered a presentation on a proposal for minimum performance requirements (MPR) and metrics for incorporation in the eHDV GTR draft text.

The Chinese delegation highlighted popular cell chemistries, cyclic performance and their battery attenuation model. The Chinese delegation suggested that cycle number may be a more appropriate MPR metric.

Following this information, the Chinese delegation proceeded to outline evaluations of various vehicle eHDV categories and their suggested MPRs based on their studies.

The Chinese delegation offered a supplementary presentation suggesting that system design and working conditions would have significant influence on performance of battery durability. It is important to consider as many situations as possible when determining MPRs. The presentation also offered market analysis of various eHDV categories and their mileage compared against their in-service time at a 70 % state of health (SOH).

Lastly, the European commission presented a document comparing their previously presented Transport Technology and Mobility Assessment (TEMA) model simulation results against a published Chinese study on battery durability. The comparison showed that with slowed charging rates, battery deterioration is minimized.

Discussion

The drafting coordinator commented that the Chinese proposal appears to be roughly in line with what was previously proposed by the European Commission (EC) with the exception of the extreme long-haul segment. The EC was thinking to relax this MPR value beyond the Chinese proposal.

The co-chairs requested clarification on whether there is a direct tie between the battery chemistries presented in the slides to the proposed MPRs. The Chinese delegation elaborated that for long-haul they are just beginning to use new battery chemistries to support the vehicles and to support 50 years and 1.5-million-kilometer range. Depending on the vehicle and the market we adjust the chemistry accordingly. The co-chairs reaffirmed that the data in the proposal is therefore related to the battery chemistries shown and are directly related to the MPR values proposed. Moreover, the new chemistries being developed may be able to go well beyond the suggested MPRs that China has proposed.

The Organisation Internationale des Constructeurs d'Automobiles (OICA) highlighted that slide five of the presentation particularly highlights that regional MPRs may be a good idea. OICA then began to offer feedback suggesting that it would be useful to see an evaluation of different cell technologies incorporated into the analysis in addition to round-trip cycling, not simply single direction discharge of the batteries.

OICA requested clarification on why China has not utilized an energy throughput counter for buses. The Chinese delegation communicated that bus cycles are relatively fixed without much variance throughout the day and working profile. For other heavy-duty vehicles, the application varies a lot, a coach bus in this case would be different. For these other applications, energy throughput may make more sense. OICA stated that they support the idea of scalability and the importance of looking at different regions when setting MPRs, simply due to the lack of available data. If looking at slide 10, heavy coaches would then need an energy throughput metric and it would need to be added to slide 10 information. OICA continued, the cycling data used seems to completely ignore the regenerative aspect of these vehicles. It appears to only be looking at the installed energy and throughput but not the regeneration and so cycles can get very tricky and need to be considered much more closely. Cycles are relatively undefined. All of this data appears to be lithium-iron-phosphate (LFP) battery centric which is resulting in restrictive battery chemistry data because of China's focus on LFP technology. China repeated that they are recommending LFP technology for the current applications and are in the process of developing different chemistries for the various working applications. OICA

asserted that they are simply pointing out that China appears to be very focused and biased towards certain technologies while this is not the same case for other jurisdictions such as Europe. We cannot be technology restrictive when developing these sorts of things. China stated that through their experience, energy consumption is relatively fixed for buses because the operation is fixed and the energy consumption is directly related to the weight of the vehicles. The consumption is relative to the weight and it may be good to use throughput or years or kilometers. OICA followed up asking if electrified coaches have been included in the data. China expressed that yes it has been alongside other considerations such as long-haul, short-haul, summer cooling and winter heating. Ultimately the energy consumption varies but in our data for the different passengers and weights we need to apply higher installed energy so that the vehicle can meet the necessary kilometers for operation. These kilometers are relatively fixed while the weight of the vehicles varies and again, we are supportive of energy throughput, years or kilometers. OICA suggested that more real-world data is required to demonstrate how coaches work because they disagree that vehicle weight is exclusively linearly correlated with the vehicle energy consumption.

The Japanese delegation asked how additional battery work on the road other than vehicle propulsion is handled. We feel this is a particular concern. One option could be through virtual mileage as defined in UN GTR 22. For energy throughput, how do we determine an appropriate threshold. If we apply a cycle number, the useful life will depend on battery size. Japan prefers energy throughput but is struggling to determine an appropriate parameter to express this. Should different battery chemistries be considered too. The Japanese delegation concluded by asking OICA if they would prefer MPRs set by region. OICA responded suggesting that for cell technologies we are facing a situation where there are different cell technologies on the market and we do not know which ones will prevail long-term. The regulation must therefore be technology neutral, regardless of this. There may be a need to rethink our approach and perhaps there needs to be consideration of a worst-case scenario for these technologies at this time as the technology continues to develop. Regarding the energy throughput value, OICA has prepared some slides that will be shown later to speak to this. OICA continued to clarify that a manufacturer does not necessarily pick the battery that goes on vehicles, as the customer can pick a modular inclusion of batteries on the vehicles they are purchasing. So, it is not an exclusive manufacturer decision and this needs to be considered. The co-chairs asked OICA to confirm that they do in fact have customers instructing them on what battery chemistries to include in a vehicle? OICA clarified that there can be customers that choose to skimp on battery capacity and be fully aware that this is the decision they are making. Based on the parts presented in the toolbox, the consumers can build their own vehicles for their specific needs and ultimately, we need to be technology agnostic.

Action items

Decisions

4. HDV GTR – Comments on working draft feasibility

Documentation

- EVE-69-09e

Context

An industry expert from TUV Nord offered a presentation on feasibility of the eHDV GTR draft text as well as general feedback and specific comments.

Discussion

The drafting coordinator thanked TUV Nord for their detailed comments. They will be incorporated into the eHDV GTR draft text, as necessary.

The EC commented that there was some reference to type approval and it is clear that this GTR will be used to develop what is in the type-approval of the European Union (EU). In the detailed comments that you have provided, there are several alluding to the type-approval, and as you will see later, in the EU, the type-approval will be based on a declaration.

OICA stated that they appreciate that third parties are taking the time to comment on the draft text, looking at the details of the text as well as the consequences. We are thinking that we need a pilot phase because it is difficult to coordinate these tests. The co-chairs expressed that they are currently in discussion about setting up some testing this summer to conduct some of these GTR tests to validate feasibility.

The Japanese delegation asked how the EVE IWG will go about implementing the large amount of feedback received on the eHDV GTR draft text. The drafting coordinator communicated that these comments will be screened and implemented before the July 22nd deadline in the main text. It is unclear at this time how much can be implemented without having gone through it all. The co-chairs expressed that it is now important for EVE IWG members to review the feedback documents that have been submitted and to raise any specific concerns with these comments to the drafting coordinator.

Action items

- Drafting coordinator to review and implement comments from TUV Nord into the eHDV GTR draft text.
- EVE IWG members to review the feedback text received on the eHDV GTR draft text and raise concerns with the drafting coordinator.

Decisions

5. HDV GTR – Comments and open item positions

Documentation

- EVE-69-06e

Context

The Japanese delegation gave an updated presentation of their current positions on various outstanding topics of the draft eHDV GTR text, in addition to justifications for each of their stances.

Discussion

The drafting coordinator thanked the Japanese delegation for their input and expressed that it has already been incorporated into the draft text.

OICA expressed that it may be too early to establish some of these values outlined in the Japanese presentation, but we can entertain a discussion for now.

Action items

Decisions

6. HDV GTR – OICA position and comments on draft text

Documentation

- EVE-69-08e
- EVE-69-15e

Context

OICA gave a presentation providing insights and feedback on the eHDV GTR draft text, including:

- A monitoring phase is needed to be able to regulate battery durability for HDV, setting correct(ed) MPRs, due to different decarbonization roadmaps and technical solutions in different regions.
- For eHDV industry, the use case and vehicle type dependent MPRs are critical for fair treatment and to meet customer needs. Oversized MPRs may lead to oversized batteries just to fulfill the law, to the drawback of customers due to increased vehicle weights, less payload, etc...(no comment on pricing due to competition law).
- Capacity is the same in the charging and discharging phase, it is more reproducible and measurable and it is technology neutral during the charging process.
- Virtual mileage and the Part C odometer need to be deleted as it adds no value and is not feasible.
- The accuracy of onboard sensors and energy counter could be verified during type approval through a test rig-based component test combined with a parent vehicle test verification.
- It is important for OICA to present factors that are expected to be relevant to be collected by monitors to consider MPR metrics for heavy-duty battery degradation.

Discussion

The Japanese delegation indicated that they were not necessarily supportive of the document but were happy that there are proposals on the table. Regarding the monitoring phase, we are unsure

whether the Working Party on Pollution and Energy (GRPE) requirements support each region being able to set their own requirements, in a worst-case scenario, understanding that you support the drafting procedure. The co-chairs reiterated that with respect to how the GRPE may receive what is produced, if the monitoring phase is rejected, do we feel that it will be rejected due to specific mandate or because some contracting parties will reject it outright. Perhaps this is too speculative but essentially, our mandate is to produce a durability GTR and contracting parties have expressed the desire for MPRs, so this is what the EVE IWG is trying to produce, and this is our current goal. The EC commented that they feel the monitoring phase question is a fair point and from an EC perspective, the GTR objective is to set an initial phase of target failures that are rather conservative. At this stage we should remain general and refine the smaller details at a later phase. The co-chairs agreed that generally, creating test procedures, setting up monitoring requirements and MPRs sends a strong signal on what are the important parameters for the vehicles. If the EVE IWG submits something without MPRs, we may need to quickly circle back and have these implemented.

Action items

Decisions

7. HDV GTR – Metric and minimum performance requirements

Documentation

- EVE-69-07e

Context

This item was linked to the proceeding meeting agenda topic.

Discussion

Action items

Decisions

8. HDV GTR – Test procedure steps and boundary conditions

Documentation

- EVE-69-07e

Context

The drafting coordinator went back to the EVE-69-07e document to elaborate on some of the topics initially introduced at the beginning of the session and to finalize some outstanding items in the eHDV GTR draft text.

Discussion

Temperature method 1a & b

The American delegation requested clarification on why there are differing tolerances between the 25-degree and 23-degree values. The drafting coordinator explained that this is simply due to the different associated testing procedures. The American delegation indicated that they have a preference for the 25-degree value because that matches the American testing procedure and are supportive of the remainder of the temperature proposal.

Test steps and family concept

The EC communicated that they feel the end of the test needs to be better defined and perhaps include a slope to ensure the battery is not fading with lower battery capacity. The American delegation was supportive of this idea and suggested that certain portions of the test could have strict speed tolerances while other sections could have detailed requirements surrounding slope tolerances.

Break-off criterion

The co-chairs requested clarification on what the term cumulative usable battery energy (UBE) means. The drafting coordinator outlined that this term is a result of battery depletion and means the total UBE replacing the total nominal energy capacity of the battery.

The Chinese delegation was supportive of the Japanese proposal of 1500 seconds to the end of the test for the break-off criterion of method 1a and 1b. Regarding the alternative method, the Chinese delegation was supportive of using a value great than five percent because it is challenging for eHDVs, even on a dynamometer measurement in a fixed environment to achieve this. The Chinese delegation also mentioned that cycle energy becomes more challenging with on-road testing. The drafting coordinator then proposed the question of whether the EVE IWG want to have the same on-road test as the lab test or something slightly different. The American delegation exclaimed that the Japanese on-road measurement proposal makes a lot of sense.

The American delegation indicated that they have a similar Society of Automotive Engineers (SAE) testing procedure as the UN GTR 22 LDV testing procedure.

OICA requested clarification on where the proposal of four or five percent is coming from. The drafting coordinator clarified that it comes from the UN GTR 22 LDV procedure with China suggesting five percent and Japan suggesting four percent, however, there is discussion that for on-road these values may need to be revised higher because it is more challenging for eHDVs.

The Japanese delegation indicated that in the past they were supportive of a constant current-rate (c-rate) while attempting to outline a c-rate profile, but this became much too complex. The Japanese delegation feels that it is important to reflect market conditions, so they do not feel that setting a specific c-rate is appropriate for this reason. The American delegation outlined that the idea of having a c-rate range is to ensure that the c-rate does not get too low or too high. These vehicles have a set payload to which they are certified to carry, so if we are talking about controlling speed and grade among other parameters, than there are probably enough constraints in the testing that the c-rate will not reach too high a level. The co-chairs stated that too high is fine but what about too low of a c-rate. The American delegation stated that if using external devices as was suggested by TUV Nord, then constraints will be required but if vehicles are being driven then there should be no

c-rate issues. If settling on a reasonable speed than there is no need to have duplicative parameters. The drafting coordinator suggested that perhaps a power rating may be useful.

The EC requested clarification on whether the testing characteristics such as speed and payload would be regional requirements or harmonized. The drafting coordinator mentioned that at this time it would be regional values proposed. The EC stated that this is fine.

The American delegation highlighted that the deceleration tolerance for the final portion of the test is constrained and whether this was necessary. The drafting coordinator stated that yes, it is necessary in a more controlled environment such as a test track.

OICA mentioned that more important than setting boundary conditions, is the repetition of these boundary conditions from test to test. OICA requested that a line of text be added to reflect this. The drafting coordinator responded that it has already been incorporated into the text for the purposes of repetition. The Japanese delegation stated that method 1b was proposed by OICA which is an on-road test, so identical boundary conditions are not possible. So, when referring to boundary conditions, which conditions are they referring to specifically, perhaps it is the temperature, but regardless this is a technical limitation of the testing. If OICA has an issue, then we would expect OICA to propose a solution. OICA responded that controlling temperature, load and traffic conditions are difficult on-road so that is why they are proposing to focus on the charging procedure. The EC mentioned that the intention of their Euro 7 regulation will be for manufacturers to declare what their battery durability will be. The boundary conditions will need to be made at the European level and conditions will apply to this certification.

The co-chairs requested clarification on why there is a need for several repetitions in the procedure. The drafting coordinator explained that as proposed by Japan, there is likely no need to have repetitions any longer. OICA suggested that there is a risk to not allowing repetitions in the test procedure because several repetitions may be required to confirm an accurate resulting value. The Drafting coordinated stated that it may be appropriate to differentiate between test repetitions to look at the monitor, regardless, test repetition can be removed from the text. The Japanese delegation communicated that if OICA wants to run additional testing then they can do so but it should not be a mandatory requirement.

Driver breaks

There was no further proposal for driver breaks other than what was presented at the previous EVE IWG session.

REESS measurement vs onboard data

There was no further proposal for rechargeable electrical energy storage system (REESS) measurement compared to onboard data, other than what was presented at the previous EVE IWG session.

Alternative methods

There was no further proposal for alternative methods, other than what was presented at the previous EVE IWG session.

Battery replacement

The co-chairs expressed that having a vehicle built for a useful life and accompanied by a set credit for the use of the vehicle for the entire period, is associated with the set amount of internal combustion engine emissions it is displacing. In UN GTR 22, the EVE IWG did not account for replacement of the in-vehicle batteries because of the associated cost and the lifecycle emissions. The American delegation outlined that in the United States for the criteria pollutants program, if a manufacturer needed a maintenance replacement, they could go through a process to have something replaced and not all components on a vehicle are subject to that useful life. The co-chairs expressed that they are not sure how to go about battery replacements because it goes against the objective of the GTR which is in-vehicle battery durability and the displacement of emissions. Perhaps if an owner had an issue, the manufacturer may not replace it with a brand-new battery but would replace it with an equivalent component to match the performance of one for the age of the vehicle.

Part A family

OICA raised a point that the use of the term battery in this context seems to conflict with the definition in other texts and perhaps there needs to be alignment of its meaning between the regulations and whether it means cell, system or something else. The drafting coordinator mentioned that they have gone and defined rechargeable electrical energy storage system and then battery separate from that to hopefully clarify these possible areas of confusion. Based on the comments received we will need to look at this further and rethink the definition. OICA reiterated that they feel the term battery is defined in the opposite manner to UN GTR 22, so this presents an unfortunate situation.

The co-chairs asked whether there should be consideration or differentiation for the application of the vehicles. The drafting coordinator explained that the vehicle application becomes more important for Part B families when testing against the MPRs. OICA expressed that for Part B, they feel that the family criteria need not be too decisive and perhaps paragraph a, D and even b could be removed to be more generic, in exchange for more specificity in Part A. The Japanese delegation communicated that there has been a lot of discussion on defining a family for eHDV and what is the real difference between LDV and eHDV. Perhaps it is best to start with LDV families and modify slightly for eHDV, as needed. OICA suggested that the inclusion of an additional sentence permitting deviations from the family definitions in case any contracting party is not willing to remove some of the criteria definitions.

Action items

- EVE IWG members to report to EVE 70 with responses to the following outstanding topics:
 - o Temperature
 - o Road grading / slope
 - o Break-off criterion for HD-OVC-HEVs
 - o Alternative method

Decisions

- EVE IWG members agreed on the following outstanding items which can be seen in the latest version of the eHDV GTR draft text:
 - To keep both Method 1a and Method 1b testing procedure.
 - Time based driver breaks.
 - Draft text surrounding the run-in of HD-PEV and HD-OVC-HEV.
 - The use of cruise control.
 - The verification and qualification of on-board data (current and voltage).
 - Steps of the test procedure.
 - Test repetition removal.

Day 2 – April 17, 2024, 09:00 KST

1. Introduction, review of agenda

Documentation

- EVE-69-19e

Context

The EVE IWG co-chairs addressed members and welcomed everyone to the virtual meeting.

The co-chairs presented the meeting agenda to EVE IWG members. The agenda was reviewed and adopted by the EVE IWG prior to beginning discussions. Modifications to the agenda occurred and have been reflected in EVE-64-19e.

Discussion

The Korean delegation reminded EVE IWG members to ensure they sign the attendance sheet.

Action items

Decisions

2. UN GTR 21 – Revised proposed plan

Documentation

- EVE-69-04e

Context

The Japanese delegation presented a document outlining their revised proposal for the expansion of the application of system bench testing. The Japanese delegation highlighted three initiatives planned, including:

- Identify loopholes and establish an assurance logic with no omissions.
- Prove the accuracy of the system bench.
- Planning demonstrations to familiarize people with the system bench.

Discussion

The Japanese delegation informally invited anyone who is interested in seeing a demonstration of their system bench prior to the in-person EVE IWG session planned for Japan on September 18-19, 2024.

The Chinese delegation asked whether a system bench is widely used in Japan, as it is not very common in China in terms of testing facilities. The Japanese delegation responded that a system bench is used for certification and improves efficiencies in the process.

OICA said that they feel some of the potential loopholes are a concern and no one else has a system bench. It would be a good idea to explore this option while in Japan so that everyone is able to see a demonstration. The EC communicated that they are a little hesitant to accept a system bench proposal at this time, but a demonstration would help to offer a better understanding. Another area of concern is that this system was developed by a manufacturer. The Japanese delegation highlighted that they are often seen as favouring the more conservative approach and the system bench is already applicable in the regulation, the proposal is simply to expand this to other vehicle models. Throughout our discussions we understand the concerns with this approach and we would like to better understand how we may address these concerns. We can certainly prepare a presentation and demonstration on this system bench for everyone. The EC explained that this system bench option was accepted in the first place because of the difficulty presented in some situations and so expanding it is a bit of a concern. The co-chairs expressed that manufacturers use these system benches and we cannot go and purchase one for ourselves so it becomes challenging in this aspect for us. The drafting coordinator thanked Japan for the presentation as it helps everyone to understand the idea and to the EC's point, we also feel that we should be keeping an eye on expanding this to more applications and vehicles. After seeing the system bench demonstration then we will be better informed in making a decision about expanding this in the future. The drafting coordinator expressed that the process for this system bench, if accepted, would be to identify the applicable vehicles, address the loopholes and draft text to effectively close those loopholes. Overall, I feel that this is a good start and it will be great to see the demonstration so that the group can better appreciate some of the possible loopholes. The Korean delegation mentioned that they have been monitoring this and will continue to study it aiming to make a proposal at an upcoming session.

The Chinese delegation requested clarification on how this system bench would work for highly integrated systems. As we move forward, these systems get more complex and so the mounting and testing of these complex systems may become challenging. Perhaps in phase three, we could do further research to design dedicated mountings between the motors and the reducers while looking at the data. Maybe as we move forward, we will see that the adoption of onboard data may be the best way forward for highly integrated systems. Due to calibration of speed, the maximum power remains relatively constant so perhaps this can also be considered during phase three. The drafting coordinator expressed that those all sound like reasonable suggestions and anything that can be identified as posing an issue in the future for vehicles is certainly within the boundaries of consideration going forward. OICA stated that in the future it will be increasingly difficult to instrument vehicles post-production and as part of the special interest group we have raised the possibility of manufacturers pre-instrumenting their vehicles so that testing is easier and the system is not being altered. In the EU, it did not seem to be an issue after market surveillance may be worth

considering here too. The co-chairs requested clarification on whether the vehicles will be tested and then de-instrumented later to sell. OICA communicated that they do not feel the vehicle would be sold after testing because everything has been installed and would need to be removed. The drafting coordinator suggested that a list of items be maintained for phase three of UN GTR 21. The co-chairs asked China whether they had already begun work on their proposed items. The Chinese delegation stated that they have started testing on some of the proposed items and will present the results later in the year as data is obtained.

Action items

- The drafting coordinator and the secretariat to maintain a list of UN GTR 21 items to consider for during phase 3.

Decisions

3. UN GTR 22 – Use of simulations for driving ranges of BEVs

Documentation

- EVE-69-12e

Context

The Korean delegation gave a presentation on the development of a simulation tool that is targeting use in evaluating the driving range of electrified vehicles.

Discussion

OICA raised some questions regarding the validity of the model under development. The Korean delegation explained that they have spent a lot of time working to improve the model. As they receive more data the model is updated, adding to the knowledge of vehicle performance. This is very much ongoing research and the more research and information added, the higher fidelity the model becomes.

Action items

Decisions

4. Results of Korean research pre-test

Documentation

- EVE-69-14e

Context

A representative from LG Energy Solutions presented some preliminary results for the durability testing of in-use taxis, following UN GTR 22 procedures.

The results illustrated that:

- The durability of the vehicles was higher than expected.
- Results vary slightly but the state of certified range (SOCR) and the SOH appear to be similar between vehicles.

Discussion

OICA expressed that this appears to be great work and the high SOCR values could be due to the official value rather than the certified value. The nominal battery energy appears to be used rather than the starting energy. The representative from LG Energy Solutions expressed that more work needs to be done to investigate the values alongside manufacturers and reminded everyone that these are preliminary results but a large-scale test is intended to confirm the values. The EC stated that this information is interesting for their own research and they have done similar but were not able to remove the batteries from the vehicles for their testing. The United Kingdom (U.K.) delegation communicated that they have also done similar research and would like to present their research at a future EVE IWG session. Like the EC, they have not been able to remove batteries from their vehicles.

OICA requested the age of the vehicles used in the testing. The representative from LG Energy Solutions stated that the vehicles are from the 2021 calendar year.

The co-chairs asked what kind of environmental conditions the vehicles have been subjected to. The representative from LG Energy Solutions responded, indicating that they are trying to compare vehicles that have been exposed to a wide variety of environmental conditions. This will be an important point in the data and because these are preliminary results we cannot say for sure just yet. When the full-scale test is underway, they plan to analyze environmental data at that time. These are taxis from the same very warm, southern area of South Korea. Electric vehicles have not existed in South Korea for very long and so it is very difficult to find sufficiently aged passenger vehicles which are not taxis.

The drafting coordinator asked what type of charging was used on the vehicles. The representative from LG Energy Solutions communicated that they have this data and have been acquiring that and other data from the battery management system (BMS) using a specialized tool installed in the vehicles.

The drafting coordinator asked whether there were any plans to retest these vehicles in several years to evaluate calendar aging. The representative from LG Energy Solutions stated that yes, they will try the test again in a few years. They are trying to test vehicles with diverse mileage and trying to accumulate as many vehicles as possible to do this.

A representative from TUV Nord stated that it would be nice to have a comparison of the SOH read from the dashboard in addition to the vehicle level for each of these vehicles, to evaluate the deviation.

Action items

- The U.K. to give a presentation on battery durability testing at a future EVE IWG session.

Decisions

5. Korean EV battery regulation

Documentation

- EVE-69-18e

Context

The Korean delegation gave a presentation outlining their plan to enact an in-vehicle battery durability regulation in Korea.

Going forward the Korean delegation is looking to:

- Conduct a study on the variation of monitor accuracy as vehicles age.
- Conduct a study of sampling methods for selecting vehicles as well as the number of samples depending on the lifetime of the vehicles.

Discussion

The co-chairs asked whether the Korean delegation plans to enforce the durability requirements or just monitor them for now. The Korean delegation stated that the MPR in the regulations appears to be quite low for Korean vehicle manufacturers, but we have seen that Part A is more difficult, so we are looking to use the SOH monitor when determining reuse or recycling of a vehicle and battery. Korea is looking to improve the SOH monitor accuracy and electric vehicle (EV) sustainability. The drafting coordinator commented that there are also concerns regarding the aging of the monitoring system and it is good that Korea is looking into this area.

OICA requested clarification on why Korea used the SOCR value. Korea stated that they will use the certified range as a default range value for the regulation, which will differ from the GTR state of certified energy (SOCE) and state of certified range (SOCR) values and is specific to the Korean regulation.

The U.K. delegation asked whether there was a timeline for requiring SOH monitors in Korea. The Korean delegation outlined that they do not have a timeline at this moment, but they are going to start their regulation immediately following the U.S. and EU implementation of their regulations. The American delegation highlighted that their regulation will come into force in 2027 for durability.

Action items

Decisions

6. UN GTR 22 – Position on work planning

Documentation

- EVE-69-05e

Context

The Japanese delegation offered a presentation overview of their proposed position on the UN GTR 22 work planning topics raise during EVE 68. Japan proposed that not off-vehicle charging hybrid electric vehicles (NOVC-HEV) should not be covered by UN GTR 22.

Discussion

OICA expressed that they feel the Japanese slides summarize well what the EVE IWG had discussed several years ago and that there is no need for durability requirements for NOVC-HEVs as it falls out of regulatory scope. To emphasize the difference between plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV), what these deal with is battery cycling. However, for NOVC-HEVs this is not necessarily done because the batteries are being maintained at the same state of charge and providing energy as needed. The way these batteries are used is completely different than what UN GTR 22 is targeting. UN GTR 22 would have to be completely redone if the EVE IWG wanted to target these NOVC-HEVs.

Action items

Decisions

7. UN GTR 22 – Part C family comments

Documentation

- EVE-69-03e

Context

OICA presented its comments regarding UN GTR 22 topics, focusing on the Part C family concept and the SOCE resolution. OICA concluded that:

- For the Part C family, since it is an algorithmic validation, the same concept as the Part A family can be used.
- How the SOCE is displayed to customers varies by market and therefore the current text should remain unchanged.

Discussion

The drafting coordinator indicated that UN GTR 22 has been updated to include these proposals as they seem reasonable to consider. The updated text will be added to the wiki page for everyone to view. There were also comments regarding the number of digits to display, such as including many more digits; however, OICA seems to be expressing that they wish to leave the value as is.

Action items

- EVE IWG secretariat to upload the latest UN GTR 22 text to the wiki page.

Decisions

8. Overview of Euro 7

Documentation

- EVE-69-16e

Context

The EC provided a presentation outlining the newly adopted Euro 7 regulation, which were finalized on April 12, 2024. The overview included details on timelines, implementing legislation and eHDV battery durability requirements.

Discussion

A representative from LG Energy Solutions suggested that the MPR had been increased and was wondering why this has occurred. The EC stated that their parliament insisted on these requirements and it is now unclear how the altered value will be included back into the eHDV GTR to realize equivalency.

The U.K. delegation asked whether the review clause included in the regulation was only for heavy duty vehicles (HDV). The EC stated that the review clause will be for both HDV and LDV.

OICA asked what data will be used as part of the HDV review. The EC commented that this still needs to be determined but if industry can support them with data, it would be very helpful. We will use several different sources of data to inform a decision. OICA requested that the EC allow them to discuss internally and perhaps coordinate a future discussion on how best to support them going forward with the data request. The chair of the GRPE pointed out that there still appears to be some placeholders, in terms of addressing some of the UN matters. It will be interesting to see what is done with these. Light-duty seems to be in line with the UN Regulations but not so with HDV. The GRPE has some upcoming workshops to tackle some of these question marks, potentially. Regarding the determination of carbon dioxide emissions, we have the tools and there will be some workshops where we work on this in Geneva, so hopefully we will be able to inform some of these placeholders. Is the EC planning to bring forward these items in Geneva to align? The EC indicated that under the 1958 agreement, certainly there is desire to establish alignment, it will take time but as soon as things have been established, we foresee working in parallel to bring the items forward.

An industry representative pointed out that, with regard to battery durability for HDV, there will be a declaration of the manufacturer, but the testing used by the manufacturer to determine the UBE will likely need to be used for the in-service conformity. The EC stated that this was something they were trying to highlight and may need to be revisited. There is no certification test, just a declaration, and we need to decide how we will go about determining this. OICA commented that the declared value of the vehicle will impact the simulation values, and these will be used within the Vector system. The EC added that this is correct and there will be additional benefit for those manufacturers that declare a larger performance value.

The American delegation asked if there were any additional requirements for the additional lifetime beyond the main lifetime requirements. The EC clarified that no there are not really any additional

requirements. For the additional lifetime there are some multipliers at play to make things a little less stringent.

OICA asked whether the EC is planning to make additional MPRs for the additional lifetime provisions. The EC stated that yes there will be and they are shown on slide 10. The American delegation questioned what flexibilities exist for the MPRs and if it is related to the SOH value. The EC responded that it is anticipated that the table on slide 10 will be filled and in the GTR there is an intention to set requirements for the different vehicle categories unique to each region such that each jurisdiction can ensure their requirements are met in this manner. Additional metrics such as energy throughput will be looked at later.

OICA requested clarification on how manufacturers will fill out the declarations and will there be official legal documents. The EC clarified that this is to be decided in the discussions of the implementing acts and the verbiage of the statement but no action to be taken at this time.

OICA asked if Article 18 will only be applicable to MPRs or will it give room to other characteristics. The EC stated that they feel Article 18 will be discussed and the appropriateness will be determined for setting the requirements which could be broader than simply the MPRs. In terms of implementation there would need to be a delegated act and this requires a few months, which seems sufficient in this situation.

The Chinese delegation asked whether the batteries need to meet MPR requirements for the main and additional lifetime requirements and does the verification of lifetime begin five years after the vehicle obtains certification or five years after the regulation comes into force. The EC responded, requesting the Chinese delegation to email them and they will offer a response following internal clarification.

Action items

- The Chinese delegation to email the EC to receive clarification on their question surrounding MPRs and verification testing in Euro 7.

Decisions

9. Swappable battery durability GTR proposal

Documentation

- EVE-69-11e

Context

The Chinese delegation offered a proposal overview for a regulation on battery swapping electric vehicles (BSEV). The proposal included a regulatory framework, battery performance requirements, values to be read from BSEVs and SOCE pack level testing and verification procedure.

Discussion

The co-chairs stated that the idea is for this technology to move beyond China but questioned whether anyone was aware of anything happening outside of China at this time. The American delegation communicated that there is nothing happening for this at this time in the United States (U.S.). The Japanese delegation communicated that there are some manufacturers that have tried demonstrations but there are no vehicles in the market at this time. The Swedish delegation indicated that battery swapping is prevalent more so in Norway than in Sweden, but it is unclear how many vehicles are in the market at this time. OICA stated that there have been rumours of swap stations being developed in regions, but they have not yet seen any and there has not been any further substantiation to this. The Swedish delegation suggested that there are some present but there are no regulations for them at this time. There is at least one swap station in Sweden and several in Norway. The Norwegian delegation stated that they could confirm that there are battery swapping stations in Sweden, Norway as well as Germany. There is currently a goal of building 18 battery swapping stations in Norway and the current number of stations in operations are two or three. OICA mentioned that they have conducted some pilot testing of this program and in the U.S. there does not appear to be anything planned yet.

The Chinese delegation communicated that they feel this technology is not exclusive to LDV and has many potential applications in eHDVs. China expressed that they feel a plan should be made to do something to address battery swapping in UN GTR 22 or produce a new UN GTR. In the future we feel this technology will get more popular, so it is worth considering. The American delegation communicated that from the U.S. perspective and under the Clean Air Act it will be extremely difficult to implement regulation on this. It was challenging enough to set battery durability requirements for permanent batteries installed in vehicles so swapping would be even less likely. There is potential to get creative and have the swapping requirements tied to maintenance requirements. For a lot of our standards, we allow scheduled maintenance and if including battery swap into that scheduled maintenance it could be a possibility. OICA recalled that the co-chairs in the past indicated that these swappable batteries fall outside of the scope of UN GTR 22 and would fall to the battery regulation instead. The Japanese delegation highlighted that they feel in the case of swappable batteries there are three possibilities including, the proposal by China, maintenance requirements, or modular battery swapping for different use cases of the same vehicle.

The drafting coordinator expressed that batteries go through calendar aging and what would happen if the battery has aged too much and swapped for a new one. How do we control swapping when the consumer is not happy with the vehicle performance. The Chinese delegation suggested that perhaps vehicle manufacturers can oversee the testing in order to determine the performance. OICA commented that if you are suggesting using many different batteries in many different vehicles, which manufacturer will listen to this complaint and would all of the batteries be universal for each vehicle. Perhaps it is not the vehicle manufacturers but an independent supplier, however, this adds complexity to these considerations. The Chinese delegation indicated that for NIO there is a separate battery company that operates and coordinates the batteries themselves. In the future the swapping companies should oversee the battery durability, maintenance and other items.

The co-chairs commented that within the context of the EVE IWG we handle vehicle durability regulations and this is the heart of the issue, everything is enforced at the vehicle level. So, if a

battery fails there would be no means of enforcing it beyond the vehicle level. In general, we support the concept of preventing these batteries from ending in a landfill, but it is a challenge to consider at the vehicle level. OICA suggested that this battery swapping seems to be more of an aftermarket situation for vehicles and it should really be out of scope for any vehicle manufacturer. The American delegation communicated that there needs to be a determination of who is the regulated party and the EVE IWG needs to understand the benefit of controlling degradation in a pool of batteries that are circulating publicly.

OICA asked whether the battery can be swapped and just charged and how do you confirm battery durability. The Chinese delegation indicated, yes, it could be just charged and if the vehicle can verify the batteries, then the swappable battery companies can choose to go with either the vehicle level or the battery level testing and if going the battery level route, the batteries can be selected from the company and tested. If selecting the vehicle level, then this would be like the current UN GTR 22 requirements. The co-chair commented that for this to occur then the batteries would need intelligent systems. An industry representative highlighted that in the current European market the battery is not necessarily the property of the customer but seen as a rental. If the battery is bought there is no permission to swap at a swapping station.

The U.K. delegation commented that in their general opinion, they feel that the EVE IWG is not in a position to commit to a new GTR, but they do feel it is worth considering and monitoring as we move forward. What we do not want in the future is a situation where it is too late and all of these swappable stations are already fully developed and built out across various jurisdictions. Perhaps keeping this item in the Terms of Reference of the EVE IWG is appropriate and the EVE IWG can monitor how developments continue. The co-chairs expressed that they feel this will remain on the EVE IWG list of action items going forward and continue to monitor it

Action items

- EVE IWG to continue to monitor swappable battery station developments and consider future action, if warranted.

Decisions

10. HDV GTR – Review of draft text

Documentation

- EVE-69-07e
- EVE-69-13e
- EVE-69-15e

Context

This item was set with the objective of going through the eHDV GTR draft text and discussing outstanding items.

The drafting coordinator gave a presentation highlighting outstanding items in the draft text as well as using the draft text itself during discussions to illustrate points.

OICA offered their document as supplementary to highlight their positions on items within the draft text.

Discussion

OICA showed their comments regarding sub-section 6.1 of the eHDV GTR draft text and stated that they would like to keep the test burden to a minimum. The co-chairs expressed that the sensor configuration and the associated algorithm for monitoring the SOCE could be dependent on the monitoring configuration, especially considering the data it is measuring. For LDV, while we were not prescriptive in the algorithm, everything that is installed in the BMS would have an impact on the battery life and operation. OICA suggested an organized and separate best practices exchange with contracting parties for the comparison of sensor and algorithm implementations and characteristics, as some may be proprietary to some individual manufacturers. The co-chairs stated that to the degree manufacturers are willing to share their information, this would be helpful. In general, we are getting a repetitive feeling of misunderstanding on why items in the eHDV GTR draft text are implemented in their current manner.

The Japanese delegation expressed confusion on the comments made and why they seem to have been done in direct comparison to an old version of the draft text. OICA communicated that comments were made on version 15 of the draft text because version 16 just came out recently.

The Japanese delegation stated that a manufacturer can increase, but not decrease, the number of families as part of the family definitions and this is how the text is currently written. OICA commented that they feel there is the ability to allow deviation through a deviation of the criteria and increasing families. The Japanese delegation remarked that from OICA's statement this seems reasonable, however, regarding comments on sub-section 6.1 requesting flexibilities but then requesting reduced testing burden, these ideas conflict. The co-chairs indicated that Part A is all about features that impact the integrity of the monitor itself. How many vehicles can we project the requirements onto where the grouping remains accurate. Part A is about the high integrity of the monitor and accuracy. OICA expressed this as fair but then suggested eliminating paragraph f because it has no impact on the battery. The co-chairs requested confirmation that the size and shape of a battery does not matter and these batteries can have the same monitor. OICA confirmed yes, this is correct. The co-chairs followed up and indicated that the way paragraph f is structured is that there are several characteristics that may drive the characteristics of the battery monitor but if a manufacturer sees that one of the characteristics may cover all the battery configurations, then it offers the flexibility to the manufacturer.

The co-chairs commented that we have a Part A and the characteristics for a family so we may need a statement that ensures we use the same test procedure for monitoring Part A and Part B. The drafting coordinator asked if there are different vehicles using the same software, should the testing procedure be the same. OICA said that yes it should be the same test procedure. The Swedish delegation commented that to better understand paragraph g test type of the Part A family definitions, we are saying that the test type during type approval should be the same as the test certification. The monitor should not have any effect on what type of test is being performed, so what is the problem with different testing types. The Japanese delegation commented that the

objective of Part A verification is to determine SOCE and test method 1b is on-road testing, so it becomes almost impossible to duplicate. OICA agreed with the Japanese comment and added that there are also varying accuracies between the two test types.

OICA proceeded to show comments regarding the Part B family definitions. The co-chairs stated that based on what has been shown it appears things can be left as-is because there is a line at the end of the sub-section adding flexibility for manufacturers to speak with authorities. OICA suggested that perhaps a line be included that refers to some families being subject to a review in phase two of the regulation using real-world data, rather than having manufacturers negotiate with each jurisdiction. The co-chairs acknowledged that true durability needs to be monitored and there is a possibility that the management of families and the monitors could be troublesome in this process. The Japanese delegation indicated that they do not support this proposal because it should be in the form of a technical report and not part of the GTR process. The American delegation commented that the reason for having vehicle categories is because these categories are tied to the standards and presumably there will be different MPRs for the different vehicle categories. It seems a little strange to be mixing and matching procedures, families and MPRs. An industry representative suggested modifying the term normal charging power in paragraph a of Part B to something that more directly impacts battery durability. Normal charging behaviour does not impact vehicle battery durability until you start to get above one megawatt of power.

OICA proceeded to review their comment on Part C family definitions. The American delegation commented that if there is no virtual mileage parameter then there is no need for a family to be defined. Is there a need for an energy throughput monitor here. OICA suggested that virtual mileage verification could be done during the verification run or through Part A. The American delegation agreed that doing this verification as part of other processes would mitigate further definitions and seems reasonable. OICA requested clarification on whether energy throughput was a value that has been decided upon at this point. The drafting coordinator indicated that it is currently only part of the monitoring phase because there needs to be a conversion factor and the monitoring will help determine this value. The other idea was to introduce guidance. OICA asked what the outcome of the monitoring phase will be. The drafting coordinator responded that it would be the application of the conversion factor. The American delegation indicated that virtual mileage and throughput both present the challenge of a conversion factor so the advantage of one over the other is not readily apparent. The co-chairs expressed that it sounds as if a Part C family definition will be necessary regardless, virtual distance or throughput, both need conversion factors. The drafting coordinator and OICA agreed that Part C families will need to be defined.

The co-chairs asked how important it is to define the different energy flows coming from the battery as illustrated in the virtual distance equations. OICA commented that it might be important to account for battery recharging from auxiliary devices because it adds additional load to the battery, in addition to discharging. The American delegation questioned the value of having bidirectional energy accounted for as using half the value would result in half the result since you can only discharge what you are charging. OICA clarified that there are many different scenarios and road conditions, vehicle loading among other factors. Take for instance a vehicle that is designed heavily for battery recharging, this can impact battery durability. The American delegation did not agree and

insisted that half the value results in half the outcome in this situation. OICA expressed that they would like to discuss this further internally and come back with a response.

OICA proceeded to present comments on the pass/fail criteria. The American delegation commented that when looking at the data provided, is there a possibility of separating the effects of the test from the determination of the UBE and what are the operating conditions at the end of the test. Was this stable or dynamic conditions because we know this can end a test early through voltage peaks. OICA responded that additional voltage is being put in and resulting in more inaccuracy and consequences of degradation are greater for voltage than current. The voltage signal inaccuracy and variation are causing the failed test. It is not due to the inaccuracy of the monitor. The American delegation suggested that whenever incorporating voltage data it seems that values automatically incur six percent inaccuracy so it suggests there may be other factors at play here. OICA expressed that they feel this is a trivial factor due to driver inaccuracy as one is done on a chassis dyno and another test is done on a track leading to testing variation. The American delegation reiterated that they are simply looking to better understand so please respond to our original request, if possible, to help inform the process. The Japanese delegation questioned whether there were any concerns with the onboard SOCE accuracy since it is used to determine UBE and BMS control. If this signal is used for other purposes, how is it possible to manage an accurate value. OICA stated that everything in the vehicles are controlled based on ampere-hours. Energy is just a virtual metric and the only metric you can use, such as steering the vehicle, is a measure of ampere-hours. The Japanese delegation asked whether voltage sensors were only installed exclusively for the purposes of this GTR. OICA stated that of course voltage sensors are installed to monitor the health of the battery, but ampere-hours is what counts. The Japanese delegation suggested that the metric of useable battery capacity (UBC) could be used instead of UBE or there is a possibility of bypassing with a tolerance. The Japanese delegation commented that inaccuracies are coming from on-road or on-track testing, so on a chassis dyno there is no worry of the accuracy of the voltage monitor. OICA clarified that they do not do any chassis dyno testing. The EC commented that the argument of UBC and UBE is plausible but what matters is the energy available from the battery. We could settle on a UBE that accurately reflects the UBC. If we do a regulation with only UBC then there is concern that we are forgetting about all the future technologies and possible developments. We would be personally worried if UBC is the sole metric, which could disincentivize future developments. OICA communicated that they intend to bring forward a proposal to demonstrate UBC and the use of SOH to illustrate an accurate value for battery condition.

Action items

- OICA to give a presentation and proposal on the use of UBC and SOH.

Decisions

11. Future planning and logistics

Documentation

- EVE-69-17e
- EVE-69-20e

Context

This item was set with the objective of discussing future meeting plans and logistics.

The Japanese delegation provided further details of the in-person EVE IWG session scheduled for September 18-19, 2024, in Tokyo, Japan.

The secretariat presented a document outlining proposed future meeting dates for the EVE IWG leading up to the eHDV GTR submission deadline on July 22, 2024.

The drafting coordinator for UN GTR 22 offered the position to anyone who is willing to take on this role.

Discussion

The co-chairs expressed that due to the tight deadlines, future agendas leading up to the GRPE submission deadline, on July 22, will have set eHDV discussion topics to ensure that everything is able to be addressed as part of the sessions.

The EC commented that the proposed drafting session on July 9, 2024, may pose a vacation conflict issue.

The Korean delegation asked whether the Japanese meeting dates are fixed as this is a national Korean holiday. The Japanese delegation indicated that yes, these dates have been finalized from voting.

The co-chairs communicated that the drafting coordinator position for UN GTR 22 is open and if anyone is interested in this role to get in touch with them. There is also the possibility of having a new drafting coordinator for UN GTR 21 and shifting the current UN GTR drafting coordinator duties to UN GTR 22. OICA expressed that it may be worth offering the role to a technical authority and certification expert for ease of understanding the process.

Action items

- Secretariat to send out future EVE IWG invitations.
- Secretariat to develop future EVE IWG agendas with fixed HDV topics.
- EVE IWG members that are interested in taking on the drafting coordinator role for UN GTR 22 or UN GTR 21 to inform the leadership team of their interest.

Decisions

12. Closing remarks

Documentation

Context

This item was set with the objective of closing the meeting.

The co-chairs thanked the Korean delegation for the exceptional hospitality and for organizing in-person attendance for the EVE IWG.

Discussion

Action items

Decisions