Submitted by the EVE informal working group

Informal document **GRPE-84-11**
84th GRPE, 12 November 2021
Agenda item 3

Electric Vehicles and the Environment (EVE IWG)

REPORT TO GRPE 84TH SESSION

GRPE EVE Agenda Item

3. Electric Vehicles and the Environment (EVE)

(a) UN GTR No. [XX] on in-vehicle battery durability

GRPE may wish to consider a proposal by the IWG on EVE for a new UN GTR on in-vehicle battery durability.

Documentation: (ECE/TRANS/WP.29/GRPE/2021/18)
GRPE-84-01, GRPE-84-02

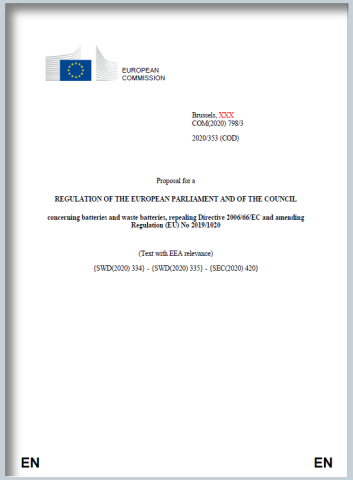
(b) Other activities of IWG on EVE

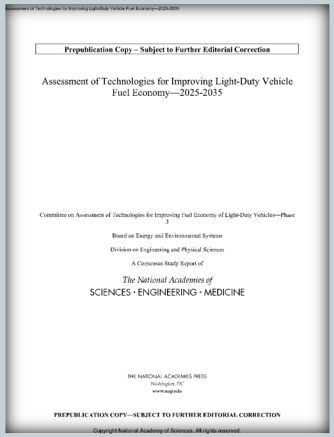
GRPE may wish to consider updated terms of reference and rules of procedure for the IWG on EVE.

Documentation: (GRPE-83-30), GRPE-84-10

Electrified Vehicle Durability Importance

- New Battery Regulation proposal in EU recognizes the importance of performance criteria for batteries and mentions work of EVE IWG
  - https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2312
- In US National Academy of Science's recent report: "Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy—2025-2035" concluded that
  - "Battery degradation is important to cost and consumer acceptance, but real-life degradation is not well understood."
  - https://www.nationalacademies.org/our-work/assessment-of-technologies-for-improving-fuel-economy-of-light-duty-vehicles-phase-3
- California Air Resources Board (CARB) recently presented "Assurance Measures", which included electrified vehicle durability requirements, during a public workshop on their Advanced Clean Car (ACC) II program.
  - https://ww2.arb.ca.gov/events/public-workshop-advanced-clean-cars-ii



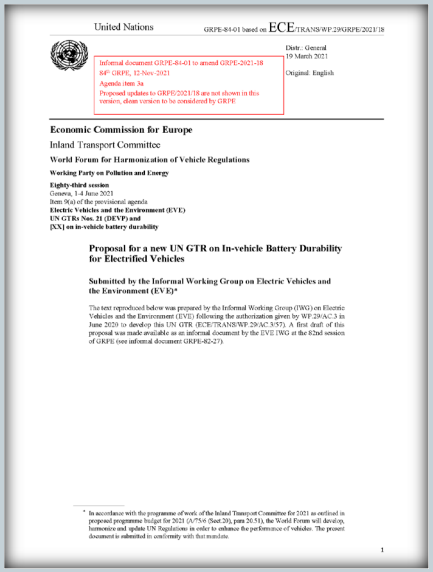


What does this GTR accomplish?

- Requires two state-of-health (SOH) monitors for energy and range
- Establishes minimum performance requirements for electrified vehicle battery degredation based on energy retention
- Establishes procedures for establishing vehicle families, verification of the SOH monitors, and the durability performance requirements.
- Implements data gathering to inform future versions of the GTR
- Helps to ensure the full environmental benefit of electrified vehicles
- Provides consumers with additional confidence with the long-term utility of electrified vehicles

In-vehicle Battery Durability GTR

Informal document GRPE-84-01 to amend GRPE-2021-18



United Nations GRPE-84-01 based on ECE/TRANS/WP.29/GRPE/2021/18

Informal document GRPE-84-01 to amend GRPE-2021-18
84th GRPE, 12-Nov-2021
Agenda item 3a
Proposed updates to GRPE/2021/18 are not shown in this version, clean version to be considered by GRPE

Distr.: General
19 March 2021
Original: English

Economic Commission for Europe
Inland Transport Committee
World Forum for Harmonization of Vehicle Regulations
Working Party on Pollution and Energy
Eighty-third session
Geneva, 1-4 June 2021
Item 9(a) of the provisional agenda
Electric Vehicles and the Environment (EVE)
UN GTRs Nos. 21 (DEVP) and
[XX] on in-vehicle battery durability

Proposal for a new UN GTR on In-vehicle Battery Durability for Electrified Vehicles

Submitted by the Informal Working Group on Electric Vehicles and the Environment (EVE)*

The text reproduced below was prepared by the Informal Working Group (IWG) on Electric Vehicles and the Environment (EVE) following the authorization given by WP.29/AC.3 in June 2020 to develop this UN GTR (ECE/TRANS/WP.29/AC.3/57). A first draft of this proposal was made available as an informal document by the EVE IWG at the 82nd session of GRPE (see informal document GRPE-82-27).

* In accordance with the programme of work of the Inland Transport Committee for 2021 as ratified in proposed programme budget for 2021 (A/75/6 (Sect.20), para 20.51), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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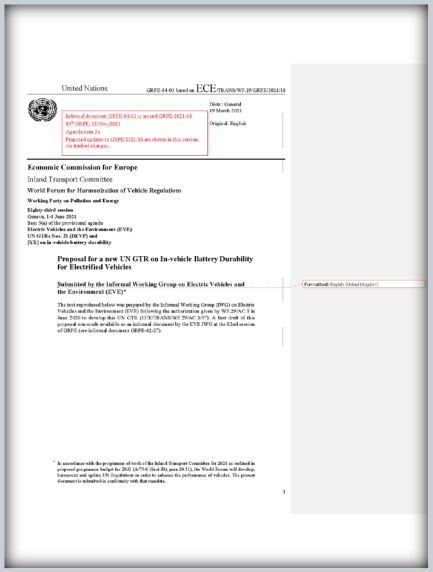
Proposed updates to GRPE/2021/18 are shown in this version, via tracked changes



United Nations GRPE-84-01 based on ECE/TRANS/WP.29/GRPE/2021/18

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Formatted: English (United Kingdom)

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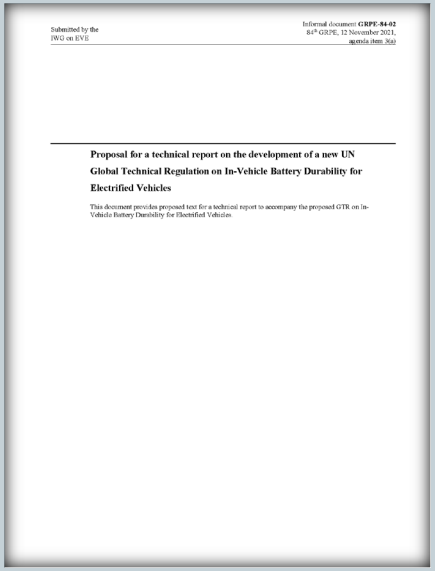
Proposal for the Technical Report



Submitted by the
IWG on EVE

Informal document **GRPE-84-02**
84th GRPE, 12 November 2021,
agenda item 3(a)

Proposal for a technical report on the development of a new UN Global Technical Regulation on In-Vehicle Battery Durability for Electrified Vehicles

This document provides proposed text for a technical report to accompany the proposed GTR on In-Vehicle Battery Durability for Electrified Vehicles.

GRPE-84-02

Major Changes to GRPE/2021/18

- Added statement of technical rationale and justification
- Updated and clarified definitions
- Included V2x provision for virtual mileage
- Clarified the verification process including analytical method
- Updated vehicle survey
- Clarified data gathering
- Addition of Annex 3 describing Determination of Performance Parameter during Part A Test Procedure
- Overall, improved the text for clearer interpretation

Overview of Durability GTR

GTR Contents

I. Statement of technical rationale and justification

II. Text of the GTR

1. Purpose
2. Scope and application
3. Definitions
4. Abbreviations
5. Requirements
   - 5.1. State-of-Certified Range and State-of Certified Energy (SOCR and SOCE) monitors
   - 5.2. Battery Performance Requirements
6. In-Use Verification
   - 6.1. Definitions of Families
   - 6.2. Information gathering
   - 6.3. Part A: Verification of SOCR/SOCE monitors
   - 6.4. Part B: Verification of Battery Durability
7. Rounding

Annexes

1 Vehicle survey

2 Values to be read from vehicles

3 Determination of Performance Parameter during Part A Test Procedure

State-of-Certified Range and State-of Certified Energy (SOCR and SOCE) monitors

- State-of-Certified Range and State-of Certified Energy (SOCR and SOCE) monitors
- The manufacturer shall install SOCR and SOCE monitors that operate during the life of the vehicle. The SOCR monitor shall maintain an estimate of the state of certified range (on-board SOCR), and the SOCE monitor shall maintain an estimate of the state of certified energy (on-board SOCE).
- The manufacturer shall determine the algorithms by which on-board SOCR and on-board SOCE are determined for the vehicles they produce. The manufacturer shall update the on-board SOCR and SOCE with sufficient frequency as to maintain the necessary degree of accuracy during all normal vehicle operation.
- The on-board SOCR and SOCE shall have a resolution of 1 part in 100 and be reported as the nearest whole number from 0 to 100.
- The manufacturer shall make available the most recently determined values of the on-board SOCR and on-board SOCE via the OBD port and optionally over-the-air (OTA).
- For the purposes of consumer information, the manufacturer shall make easily available to the owner of the vehicle the most recently determined value of the SOCE monitor via at least one appropriate method. The resolution for the customer values shall be determined in agreement with the authorities. For example:
  - (a) dashboard indicator;
  - (b) infotainment system;
  - (c) remote access (such as via mobile-phone applications)

Battery Performance Requirements

Table 1
Battery Energy based (SOCE) MPR

Vehicle age/km for categories 1-1 and 1-2 in the scope of this GTR	*OVC-HEV*	*PEV*
From start of life to 5 years or 100,000 km, whichever comes first	80 per cent	80 per cent
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	70 per cent	70 per cent

Vehicle age/km for category 2 in the scope of this GTR	*OVC-HEV*	*PEV*
From start of life to 5 years or 100,000 km, whichever comes first	(Reserved)	(Reserved)
Vehicles more than 5 years or 100,000 km, and up to whichever comes first of 8 years or 160,000 km	(Reserved)	(Reserved)

Reserved = monitoring

In-use Verification: Definitions of Families

Definitions of Families

Vehicles having the same characteristics with respect to their evaluation under Part A or Part B below shall be grouped into vehicle families for the purpose of compliance verification. Families under Part A shall have the same characteristics with respect to verification of the SOCR/SOCE monitors. Families under Part B shall have the same characteristics with respect to verification of battery durability.

Families with the same characteristics with respect to compliance verification shall be defined as follows:

6.1.1. For Part A: Verification of Monitors

Only vehicles that are substantially similar with respect to the following elements may be part of the same monitor family:

(a) Algorithm for estimating on-board SOCR and on-board SOCE

(b) Sensor configuration (for sensors used in determination of SOCR and SOCE estimates)

(c) Characteristics of battery cell which have a non-negligible influence on accuracy of monitor

(d) Type of vehicle (PEVs or OVC-HEVs)

At the request of the manufacturer, with the approval of the responsible authority and with appropriate technical justification, the manufacturer may deviate from the above criteria for families.

In-use Verification: Definitions of Families

6.1.2. For Part B: Verification of Battery Durability

Only vehicles that are substantially similar with respect to the following elements may be part of the same battery durability family:

(a) Type and number of electric machines, including net power, construction type (asynchronous/ synchronous, etc.), and any other characteristics having a non-negligible influence on battery durability;

(b) Type of battery (dimensions, type of cell, including format and chemistry, capacity (Ampere-hour), nominal voltage, nominal power;

(c) Battery management system (BMS) (with regards to battery durability monitoring and estimations);

(d) Passive and active thermal management of the battery;

(e) Type of electric energy converter between the electric machine and battery, between the recharge-plug-in and battery, and any other characteristics having a non-negligible influence on battery durability;

(f) Operation strategy of all components influencing the battery durability;

(g) Declared maximum charging power.

At the request of the manufacturer, with the approval of the responsible authority and with appropriate technical justification, the manufacturer may deviate from the above criteria for families.

In-use Verification: Information gathering

- Information gathering
  - The following information shall be made available to the authorities by the manufacturer in a format to be agreed between the authorities and the manufacturer: annual report on relevant warranty claims; and annual statistics on repairs for both batteries and other systems that might influence the electric energy consumption of the vehicle. Such information shall be made available once a year for each battery durability family for the duration of the period defined in paragraph 5.2. after the last vehicle of this family is sold.

Part A: Verification of SOCR/SOCE monitors

- 6.3 Part A: Verification of SOCR/SOCE monitors
  - 6.3.1 Frequency of verifications
  - 6.3.2 Verification procedure
  - 6.3.3 Statistical Method for Pass/Fail decision for the SOCR monitor and SOCE monitor
  - 6.3.4 Corrective measures for the SOCR and SOCE monitors

Part B: Verification of Battery Durability

- 6.4 Part B: Verification of Battery Durability
  - 6.4.1 Frequency of verifications
  - 6.4.2 Pass/Fail Criteria for the battery durability family
  - 6.4.3 Corrective Measures for the Battery Durability Family

Flow Charts

Figure 1: Flow chart for Part A: Verification of Monitors

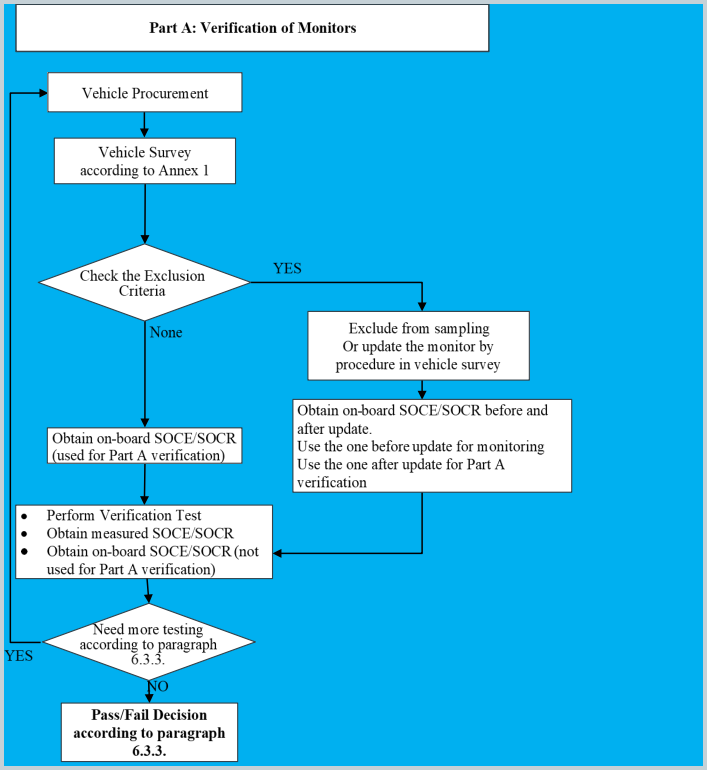
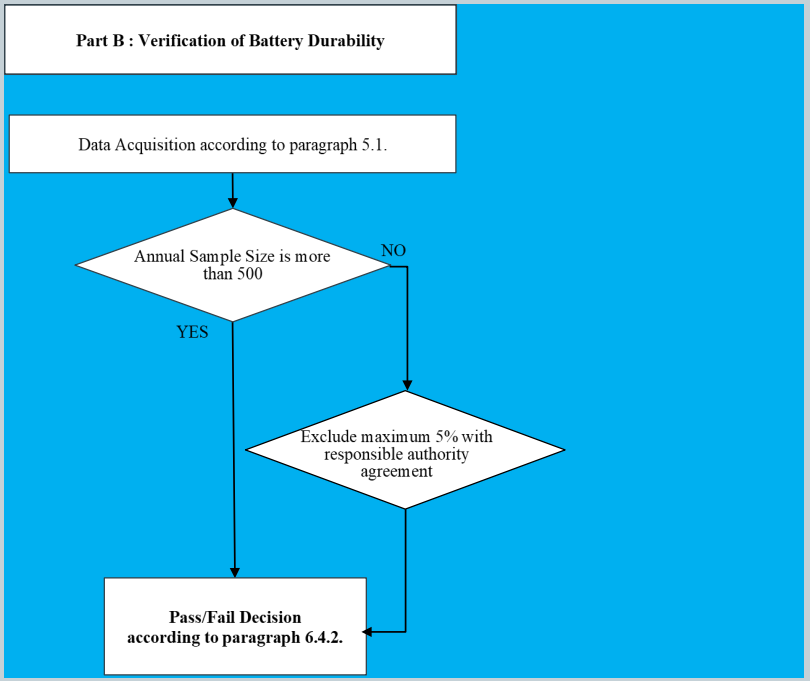


Figure 2: Flow chart for Part B: Verification of Battery Durability



ANNEX 1: Vehicle Survey

Vehicle Survey

The vehicle survey shall be used for all vehicles selected for testing in Part A of the verification. Vehicles that fall under one of the exclusion criteria below shall be eliminated from testing, or otherwise updated according to the procedures described below.

	x = Exclusion Criteria	x = Checked and reported	Confidential
Date:			x
Name of investigator:			x
Location of test:			x
Country of registration:		x	

Vehicle Characteristics	x = Exclusion Criteria	x = Checked and reported	Confidential
Registration plate number:		x	x
*The vehicle must have **age and distance** travelled (defined as the time elapsed after first registration) below the one required in paragraph 5.2. for the MPR verification*	x		
Is the vehicle either PEV or OVC-HEV? If no: the vehicle cannot be selected	x		
Date of first registration:		x	

VIN:		x	
Emission class and character or Model Year		x	
Country of registration: *The vehicle must be registered in a Contracting Party*	x	x	
Model:		x	
Engine code:		x	
Engine volume (l):		x	
Engine power (kW):		x	
Electric Engine code:		x	
Electric Engine power (kW):		x	
Electric powertrain type		x	
Energy capacity and type of battery		x	
Gearbox type (auto/manual):		x	
Drive axle (FWD/AWD/RWD):		x	
Tyre size (front and rear if different):		x	
Average fuel consumption for PHEVs		x	

ANNEX 2: Values to be read from vehicles

Values to be read from vehicles:

1. On board SOCE value
2. On board SOCR value
3. Odometer (in km)
4. Date of manufacture of the vehicle
5. Total distance (sum of the distance driven and the virtual distance) [km], if applicable
6. Percentage of virtual distance [in per cent], if applicable
7. Worst case certified energy consumption of PART B family [Wh/km], if applicable
8. Total discharge energy in V2X [Wh], if applicable
9. Last charged by more than 50 per cent SOC swing on [Date]
10. Maximum, minimum, average ambient temperature* the vehicle was exposed to during its lifetime

Note: * ambient temperature to be read as daily averages

ANNEX 3: Determination of Performance Parameter during Part A Test Procedure

Determination of Performance Parameter during Part A Test Procedure

1. General

For the calculation of SOCEmeasured and SOCRmeasured according to paragraph 6.3.2. of this GTR, the measured and certified values of usable battery energy (UBE) and electric range (PER for PEVs and EAER for OVC-HEVs) are required:

- UBEmeasured and UBEcertified
- Rangemeasured and Rangecertified

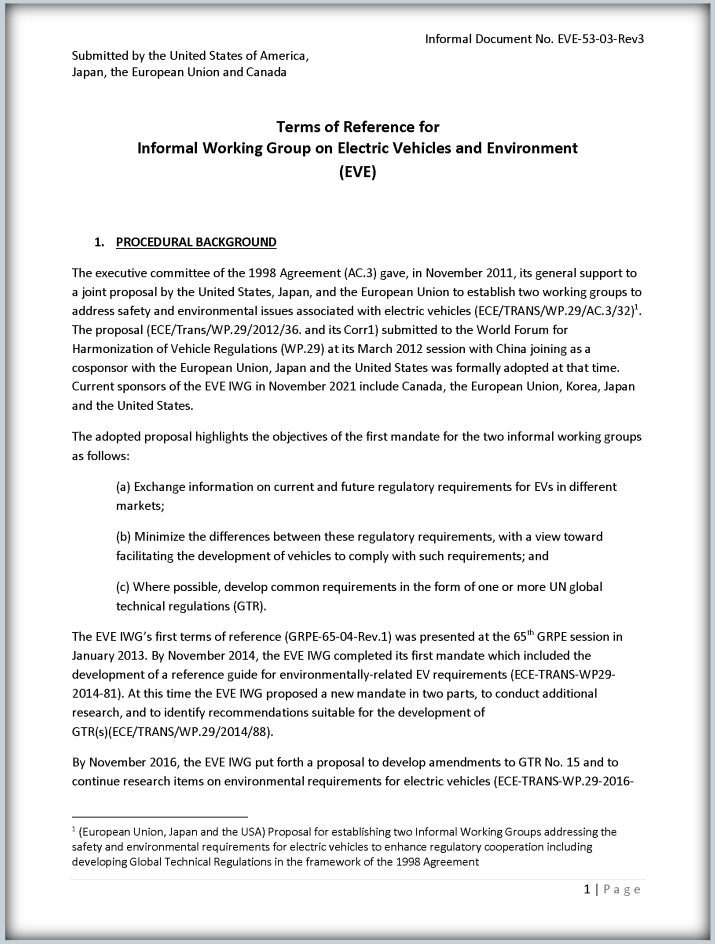
This annex describes the determination of these parameters in case of WLTP, in paragraph 2. for PEVs and in paragraph 3. for OVC-HEVs and gives guidance on which measurements need to be performed and which certified values need to be applied for a vehicle selected in the Part A verification procedure. Regions that do not apply UN GTR No. 15 (GTR15) or UN Regulation No. 154, shall define an alternative solution informed by the guidance below.

For the purposes of this annex, for PEVs the term ’battery‘ includes not only REESS used mainly for traction purposes, but also all other REESSs.

Durability Phase 2

- During the development of this GTR, the EVE identified the need for a future revision which could include:
  - Consider heavy-duty vehicles
    - EVE has already identified technical differences which preclude the direct application of light-duty vehicle requirements
  - Minimum performance requirements for range
  - Data analysis and modification to the performance requirements
  - Refinement of the verification procedures
  - Adopt Normal Usage Indices

Updated Terms of Reference



Informal Document No. EVE-53-03-Rev3

Submitted by the United States of America,
Japan, the European Union and Canada

Terms of Reference for
Informal Working Group on Electric Vehicles and Environment
(EVE)

1. **PROCEDURAL BACKGROUND**

The executive committee of the 1998 Agreement (AC.3) gave, in November 2011, its general support to a joint proposal by the United States, Japan, and the European Union to establish two working groups to address safety and environmental issues associated with electric vehicles (ECE/TRANS/WP.29/AC.3/32)[1]. The proposal (ECE/Trans/WP.29/2012/36. and its Corr1) submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) at its March 2012 session with China joining as a cosponsor with the European Union, Japan and the United States was formally adopted at that time. Current sponsors of the EVE IWG in November 2021 include Canada, the European Union, Korea, Japan and the United States.

The adopted proposal highlights the objectives of the first mandate for the two informal working groups as follows:

(a) Exchange information on current and future regulatory requirements for EVs in different markets;

(b) Minimize the differences between these regulatory requirements, with a view toward facilitating the development of vehicles to comply with such requirements; and

(c) Where possible, develop common requirements in the form of one or more UN global technical regulations (GTR).

The EVE IWG's first terms of reference (GRPE-65-04-Rev.1) was presented at the 65th GRPE session in January 2013. By November 2014, the EVE IWG completed its first mandate which included the development of a reference guide for environmentally-related EV requirements (ECE-TRANS-WP29-2014-81). At this time the EVE IWG proposed a new mandate in two parts, to conduct additional research, and to identify recommendations suitable for the development of GTR(s)(ECE/TRANS/WP.29/2014/88).

By November 2016, the EVE IWG put forth a proposal to develop amendments to GTR No. 15 and to continue research items on environmental requirements for electric vehicles (ECE-TRANS-WP.29-2016-

[1] (European Union, Japan and the USA) Proposal for establishing two Informal Working Groups addressing the safety and environmental requirements for electric vehicles to enhance regulatory cooperation including developing Global Technical Regulations in the framework of the 1998 Agreement

1 | Page

- Revised ToR's for January 2021~ June 2023
- Submitted by USA, Japan, Korea, EU and Canada
- Co-chair: USA and EC
- Vice chair: Japan
- Secretary: Canada
- Continue development of durability GTR's
  - Light-duty vehicles durability– continued work
  - Heavy-duty vehicle durability – new work
  - Power determination – continued work
- Collaboration with Group of Experts on Energy Efficiency (GEEE)
- Information sharing

EVE Meetings

- After an incredibly busy year of virtual meetings the EVE will reconvene during the GRPE and begin to form our recommended meetings for 2022 calendar year and beyond.
- Initial thoughts are that as soon as travel is possible that we will meet in Brussels, hopefully in the Spring of 2022.