Submitted by the expert from OICA

Informal document **GRPE-84-12**
84th GRPE, 12 November 2021
Agenda item 4.

Proposal to amend Working Documents ECE-TRANS-WP29-GRPE-2021-21 (proposed 02 series of amendments to UN-R 154) and ECE-TRANS-WP29-GRPE-2021-22 (proposed 03 series of amendments to UN-R 154)

This document aims to:
- apply the approach to use the number of CD cycles from vehicle for the EAER calculation (approach already implemented for e.g. Annex B8, 4.3.1.: $EC_{AC,CD}$)

The modifications to the current text of the Regulation are marked in bold for new or strikethrough for deleted characters.

I. Proposal

Annex B8, Paragraph 4.4.3. of 02 and 03 series; amend to read:

"4.4.3.   Charge-depleting cycle range ~~for OVC-HEVs~~

The charge-depleting cycle range R_{CDC} shall be determined from the charge-depleting Type 1 test described in paragraph 3.2.4.3. of this annex as part of the Option 1 test sequence and referenced in paragraph 3.2.6.1. of this annex as part of the Option 3 test sequence. The R_{CDC} is the distance driven from the beginning of the charge-depleting Type 1 test to the end of the transition cycle according to paragraph 3.2.4.4. of this annex.

In the case that the interpolation method is applied, the transition cycle of vehicle L n_{veh_L} shall be used for the R_{CDC} determination. If the transition cycle number driven by vehicle H, n_{vehH} , and, if applicable, by an individual vehicle within the vehicle interpolation family n_{vehind} is lower than the transition cycle number driven by vehicle L, n_{veh_L}, the confirmation cycle of vehicle H and, if applicable, an individual vehicle shall be used as the end of the transition cycle."

Annex B8, Paragraph 4.4.4.1. of 02 and 03 series; add at the end of paragraph:

"4.4.4.1.   Determination of cycle-specific equivalent all-electric range

The cycle-specific equivalent all-electric range shall be calculated using the following equation:

For Level 1A;

$$EAER = \left(\frac{M_{CO2,CS,declared} - M_{CO2,CD,avg} \times \frac{M_{CO2,CD,declared}}{M_{CO2,CD,ave}}}{M_{CO2,CS,declared}} \right) \times R_{CDC}$$

For Level 1B;

$$EAER = \left(\frac{M_{CO2,CS,ave} - M_{CO2,CD,avg}}{M_{CO2,CS,ave}} \right) \times R_{CDC}$$

where:

EAER   is the cycle-specific equivalent all-electric range, km;

$M_{CO2,CS,declared}$ is the declared charge-sustaining CO_2 emission according to Table A8/5, step No. 7, g/km;

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$M_{CO2,CD,avg}$	is the arithmetic average charge-depleting CO_2 emission according to the equation below, g/km;
$M_{CO2,CD,declared}$	is the declared charge-depleting CO_2 emission according to Table A8/8, step no. 14, g/km;
$M_{CO2,CD,ave}$	is the arithmetic average charge-depleting CO_2 emission according to Table A8/8, step no. 13, g/km;
R_{CDC}	is the charge-depleting cycle range according to paragraph 4.4.3. of this annex, km;
$M_{CO2,CS,ave}$	is the arithmetic average charge-sustaining CO_2 emission according to Table A8/5, step No. 6, g/km;

and

$$M_{CO2,CD,avg} = \frac{\sum_{j=1}^{k}(M_{CO2,CD,j} \times d_j)}{\sum_{j=1}^{k} d_j}$$

where:

$M_{CO2,CD,avg}$	is the arithmetic average charge-depleting CO_2 emission, g/km. In the case of more than one charge-depleting test, the additional arithmetic average of each test shall be calculated;
$M_{CO2,CD,j}$	is the CO_2 emission determined according to paragraph 3.2.1. of Annex B7 of phase j of the charge-depleting Type 1 test, g/km;
d_j	is the distance driven in phase j of the charge-depleting Type 1 test, km;
j	is the index number of the considered phase;
k	is the number of phases driven up to the end of the transition cycle n according to paragraph 3.2.4.4. of this annex.

In the case that the interpolation method is applied, k shall be the number of phases driven up to the end of the transition cycle of vehicle L n_{veh_L}. If the transition cycle number driven by vehicle H, n_{vehH} , and, if applicable, by an individual vehicle within the vehicle interpolation family n_{vehind} is lower than the transition cycle number driven by vehicle L, n_{veh_L}, the confirmation cycle of vehicle H and, if applicable, an individual vehicle shall be included in the calculation."

Annex B8, Paragraph 4.4.6.1. of 02 series; add at the end of paragraph:

"4.4.6.1.   Determination of cycle-specific equivalent all-electric range

The cycle-specific equivalent all-electric range shall be calculated using the following equation:

$$EAER = \left(\frac{FC_{CS,declared} - FC_{CD,avg} \, x \, \frac{FC_{CD,declared}}{FC_{CD,ave}}}{FC_{CS,declared}} \right) \times R_{CDC}$$

where:

EAER	is the cycle-specific equivalent all-electric range, km;
$FC_{CS,declared}$	is the declared charge-sustaining fuel consumption according to Table A8/7 Step 5, kg/100km;
$FC_{CD,avg}$	is the arithmetic average charge-depleting fuel consumption according to the equation below, kg/100km;
$FC_{CD,declared}$	is the declared charge-sustaining fuel consumption according to Table A8/9a Step 11, kg/100km;

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$FC_{CD,ave}$ is the arithmetic average charge-depleting fuel consumption according to Table A8/9a, step no. 10, kg/100km;

R_{CDC} is the charge-depleting cycle range according to paragraph 4.4.3. of this annex, km;

and

$$FC_{CD,avg} = \frac{\sum_{j=1}^{k}(FC_{CD,j} \times d_j)}{\sum_{j=1}^{k} d_j}$$

where:

$FC_{CD,avg}$ is the arithmetic average charge-depleting fuel consumption, kg/100 km. In the case of more than one charge-depleting test, the additional arithmetic average of each test shall be calculated;

$FC_{CD,j}$ is the fuel consumption of phase j of the charge-depleting Type 1 test, kg/100km;

d_j is the distance driven in phase j of the charge-depleting Type 1 test, km;

j is the index number of the considered phase;

k is the number of phases driven up to the end of the transition cycle n according to paragraph 3.2.4.4. of this annex.

The considered phase j shall be the applicable WLTP test cycle only.

In the case that the interpolation method is applied, k shall be the number of phases driven up to the end of the transition cycle of vehicle L n_{veh_L}. If the transition cycle number driven by vehicle H, n_{vehH} , and, if applicable, by an individual vehicle within the vehicle interpolation family n_{vehind} is lower than the transition cycle number driven by vehicle L, n_{veh_L}, the confirmation cycle of vehicle H and, if applicable, an individual vehicle shall be included in the calculation."

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II. Justification

1. Paragraph 4.4.3. also applies to OVC-FCHVs in Level 1A and therefore the limitation to OVC-HEVs should be deleted as this is a simple and straight forward solution to make it clear and to avoid any complex wording to explain that OVC-FCHVs just for Level 1A.

2. Recommendation to apply the number of CD cycles from vehicle L also for EAER

    a. Interpolation method working for the R_{CDC} difference of 1 cycle (between VH and VL) but manufacturer need to add a safety margin that is <u>not caused</u> by physical energy but by the calculation method (lesson learned)

    b. Approach already implemented for all further interpolated charge-depleting values e.g. for $EC_{AC,CD}$ (Annex B8, §4.3.1.).

    c. The implementation of the vehicle L approach has not be done for EAER in the first step but should be integrated in the next step (based on the lesson learned)

    d. An additional argument for the implementation of this approach is the cross-link of EAER into the "In-Vehicle-Battery-Durability GTR" (although range monitor is in monitoring for phase 1). An identical number of CD cycles for EAER calculation provides a clear and robust reference if a reference to the number of CD cycles during homologation is required. Nothing which is clear now but in case it is needed, that change will be also driven by that.