European Automobile Manufacturers Association

RCB correction application

#OIL 50

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP

Responsible working group member

Volkswagen

Description of working package

- To check the Japanese counter proposal
- HV and LV RCB correction
- Preparation of papers for ACEA internal discussion
- PHEV / BEV / HEV

Final proposal available

March 2014

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Annex 8 – ACEA-JAMA-web-audio-meeting, May 22nd

Topic 3: RCB correction of all electric energy storage devices

ANNEX 8, APPENDIX 2
REESS CHARGE BALANCE (RCB) COMPENSATION

2.1.1. The fuel consumption correction coefficients (K_{fuel}) for the individual phases as well as for the complete test cycle are defined as:

$$K_{fuel} = \frac{(n \times \sum E_{REESS} \times FC_i - \sum E_{REESSi} \times \sum FC_i)}{n \times \sum E_{REESSi}^2 - (\sum E_{REESSi})^2}$$

where:

K_{fuel} are the fuel consumption correction coefficients, l/100 km/Wh/km;

FC_i are the fuel consumptions measured during the i^{th} test, l/100 km;

E_{REESSi} are the electricity balances measured during the i^{th} test, Wh/km;

JAMA has same position as ACEA
JP gov also accepts this position

are the electricity balances of all batteries installed in the vehicle measured during the ith test, Wh/km;

ACEA:
- latest version used here:
- There is an editorial mistake regarding the delta EREESS
- Definition of delta EREESS has to be consistent in the GTR and will be changed by ACEA at the specific paragraphs

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play
Comment of Subgroup EV meeting, June 4th, Geneva

Annex 8	
OIL # 50: RCB correction application	- It is at this moment not clear whether the GTR requires that the sum of all RCB's is used for correction. - The correction might already be applied by the drafting coordinator. - There is a need to check the text of the RCB correction to see if it is implemented as agreed. - If that is not the case, ACEA will develop a text proposal; - T&E will provide feedback to that. It is not critical for the next meeting but if ready it will be presented on the meeting of the 1st of July.

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

RCB

"REESS charge balance“:
- RCB means the charge balance of the REESS measured in [Ah]
- RCB is REESS charging balance over the whole cycle [Ah]
- RCB is the REESS charge balance [Ah]
- RCB_i is the charging balance over the whole cycle for the i^{th} REESS [Ah]

- RCB_j is the measured charge balance of the traction REESS of the j^{th} phase during the charge-depleting test [Ah]

Annex 8
1.1. Energy balance
The energy balance shall be the sum of the ΔE_{REESS} of all rechargeable electric energy storage systems (REESS), i.e. the sum of the RCB values multiplied by the respective nominal V_{REESS} for each REESS.

Annex 8 – Appendix 3
3.2. The RCB values of each phase shall be recorded.

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

REESS and ΔE_{REESS}

REESS: Rechargeable Electric Energy Storage System

1.)

$$\Delta E_{REESS} = \frac{0.0036 \times RCB[Ah] \times U_{REESS}[V]}{E_{Fuel}[Wh]} \times 100\ [\%]$$

Annex 6 Appendix 2 → §3.6.

Annex 8 4.2.1.3.3.

ΔE_{REESS}

- **is the change in the REESS energy content [%]**

U_{REESS}

- is the nominal REESS voltage [V]

RCB

- is REESS charging balance over the whole cycle [Ah]

E_{Fuel}

- is the energy content of the consumed fuel [Wh]

2.)

$$\Delta E_{REESS} = \frac{0.0036 \times \sum(RCB_i\ [Ah] \times U_{REESSi}\ [V])}{E_{fuel}[Wh]} \times 100$$

Annex 8 4.2.2.3.2.

U_{REESSi}

- is the nominal REESS voltage for i^{th} REESS [V]

RCBi

- is REESS charging balance over the whole cycle for i^{th} REESS [Ah]

E_{Fuel}

- is the energy content of the consumed fuel [Wh]

ΔE_{REESS}
is the electricity balance measured during test [Wh/km]

Annex 8 - Ap2 2.3.1.

E_{REESSi}:
are the electricity balances measured during the i[th] test [Wh/km]

Annex 8 - Ap2 2.1.1.

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Situation 1: Defintion(s) of ΔE_{REESS}

ΔE_{REESS} is the change in the REESS energy content [%]	**ΔE_{REESS} is the electricity balance measured during test [Wh/km]**
Annex 6 Appendix 2 → §3.6. *Annex 8 4.2.1.3.3.* *Annex 8 4.2.2.3.2.*	*Annex 8 - Ap2 2.3.1.*
→ Delta is not the correct description, it's more a ratio	**Amendment:** ΔE_{REESS} is the electricity balance measured during test **[Wh]** **If [Wh/km] then it is electric consumption (EC)**

2 different definitions for 1 topic → inconsistency

Proposal:
- **Issue for discussion**
- **Forwarding to drafting coordinator**

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Situation 2: E_{REESSi} vs. ΔE_{REESS}	
E_{REESSi} are the electricity balances measured during the i[th] test [Wh/km] *Annex 8 - Ap2 2.1.1.*	**ΔE_{REESS} is the electricity balance measured during test [Wh/km]** *Annex 8 - Ap2 2.3.1.*
Proposal: E_{REESSi} → ΔE_{REESSi} [Wh/km] → [Wh] (otherwise it would be EC and not E)	

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Situation 3: Annex 8 – Appendix 2 (Example: Fuel Consumption)

Current version:

$$K_{fuel}[\frac{\frac{l}{100km}}{\frac{Wh}{km}}] = \frac{(n * \sum E_{REESS} * FC_i - \sum E_{REESSi} * \sum FC_i)}{n * \sum E_{REESSi}^2 - (\sum E_{REESSi})^2}$$

$$FC_0[\frac{l}{100km}] = FC - K_{fuel}\left[\frac{\frac{l}{100km}}{\frac{Wh}{km}}\right] \times \Delta E_{REESS}[\frac{Wh}{km}]$$

Questions on this version:

- Should E [Wh] be used or EC [Wh/km]? (Option 1 and Option 2)
- E_{REESS} has always to be E_{REESSi} at any time
  (R101: in this equation is Q corresponding with E)

5.3.3.2. Der Korrekturkoeffizient für den Kraftstoffverbrauch (K_{fuel}) ist wie folgt definiert:

$K_{fuel} = (n \cdot \Sigma Q_i C_i - \Sigma Q_i \cdot \Sigma C_i)/(n \cdot \Sigma Q_i^2 - (\Sigma Q_i)^2)$ (l/100 km/Ah)

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Situation 3: Annex 8 – Appendix 2 (Example: Fuel Consumption)

Current version:

$$K_{fuel}[\frac{\frac{l}{100km}}{\frac{Wh}{km}}] = \frac{(n * \sum E_{REESS} * FC_i - \sum E_{REESSi} * \sum FC_i)}{n * \sum E_{REESSi}^2 - (\sum E_{REESSi})^2}$$

$$FC_0[\frac{l}{100km}] = FC - K_{fuel}\left[\frac{\frac{l}{100km}}{\frac{Wh}{km}}\right] \times \Delta E_{REESS}[\frac{Wh}{km}]$$

Option 1:

- ΔE [Wh]
- FC $[\frac{l}{100km}]$

$$K_{fuel}[\frac{\frac{l}{100km}}{Wh}] = \frac{(n * \sum(\Delta E_{REESSi} * FC_i) - \sum \Delta E_{REESSi} * \sum FC_i)}{n * \sum \Delta E_{REESSi}^2 - (\sum \Delta E_{REESSi})^2}$$

$$FC_0[\frac{l}{100km}] = FC - K_{fuel}\left[\frac{\frac{l}{100km}}{Wh}\right] \times \Delta E_{REESS}[Wh]$$

Effects on GTR (Annex 8 – Appendix 2):

- Following equations have to be changed (E_{REESSi} has to be replaced by E_{REESS})
  - K_{fuel} (2.1.1.)
  - FC_0 (2.3.1.)
  - K_{CO_2} (3.1.1.)
  - M_0 (3.2.1.)
- Following definitions have to be changed
  - E_{REESS} has to be replaced by ΔE_{REESS}

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Situation 3: Annex 8 – Appendix 2 (Example: Fuel Consumption)

Current version:

$$K_{fuel}[\frac{\frac{l}{100km}}{\frac{Wh}{km}}] = \frac{(n * \sum E_{REESS} * FC_i - \sum E_{REESSi} * \sum FC_i)}{n * \sum E_{REESSi}^2 - (\sum E_{REESSi})^2}$$

$$FC_0[\frac{l}{100km}] = FC - K_{fuel}\left[\frac{\frac{l}{100km}}{\frac{Wh}{km}}\right] \times \Delta E_{REESS}[\frac{Wh}{km}]$$

Option 2:

- $EC\ [\frac{Wh}{km}]$
- FC $[\frac{l}{100km}]$

$$K_{fuel}[\frac{\frac{l}{100km}}{\frac{Wh}{km}}] = \frac{(n * \sum(EC_{REESSi} * FC_i) - \sum EC_{REESSi} * \sum FC_i)}{n * \sum EC_{REESSi}^2 - (\sum EC_{REESSi})^2}$$

$$FC_0[\frac{l}{100km}] = FC - K_{fuel}\left[\frac{\frac{l}{100km}}{\frac{Wh}{km}}\right] \times EC_{REESS}[\frac{Wh}{km}]$$

Effects on GTR (Annex 8 – Appendix 2):

- Following equations have to be changed (E_{REESSi} has to be replaced by EC_{REESSi}, ΔE_{REESS} has to be replaced by EC_{REESS})
  - K_{fuel} (2.1.1.)
  - FC_0 (2.3.1.)
  - K_{CO_2} (3.1.1.)
  - M_0 (3.2.1.)
- Following definitions have to be changed
  - E_{REESS} has to be replaced by EC_{REESS}

WLTP Phase 1B, working package 1

RCB correction method for phase 1B WLTP – current state of play

Conclusion/ACEA position:

Option 1 or Option 2?
……

Editorial remarks:
……