OVC-HEV Certification according to R83/R101
Mode Selection for condition A and B
OVC-HEV Certification according to UN-ECE R83/R101

Background

Current legislative text could lead to the interpretation that a mode for condition B shall be selected which is not only reflecting the energy (fuel and electric energy) used for vehicle propulsion but also the energy used for energy conversion (recharging the battery – fuel energy to electric energy).

If energy is used for energy conversion, this converted/recharged energy is reflected on the one hand side in a higher fuel consumption but on the other hand side also in a lower electric consumption.

WLTP is taking of this fact and is correcting the Sustaining Test (which is the corresponding test to condition B) towards a neutral charging balance.

R83/R101:
For NOVC-HEVs, a correction of the fuel consumption towards a neutral charging balance is described.
For OVC-HEVs, this correction is not described for condition B.

WLTP:
For NOVC-HEVs, a correction of the fuel consumption towards a neutral charging balance is described.
For OVC-HEVs, this correction is described for the Charge-Sustaining-Test (corresponding to condition B).
OVC-HEV Certification according to UN-ECE R83/R101

Question on the purpose of the test results

Question: Should the test results reflect
1. energy used for vehicle proposal and energy conversion?
2. energy used for vehicle propulsion only?

OICA position:
- Test results should reflect the energy used for vehicle propulsion only.
- Therefore, as the legislative text is not reflecting this, action is necessary to reflect this in the text
  (Uploaded informal documents)
- Proposed text is a copy from WLTP (with some adaptations), WLTP text already approved
- Although NEDC is facing out in Europe, there are still countries/regions accepting approvals according to R83/R101 and that’s why it is necessary to take action and reflect the intention of the legislation into the text of the legislation.
OVC-HEV Certification according to UN-ECE R83/R101
Measurement of energy after testing in Condition A and Condition B

Reminder: $e_1$, $e_2$, and $e_3$ have to be measured after testing in condition A and condition B

For condition A:
according to R101, § 4.2.1., the EV-mode has to be selected if you're able to drive more than one mode in pure electric operation

Remaining open question: Which mode to select for condition B? (next slide only focus on condition B)
OVC-HEV Certification according to UN-ECE R83/R101
Mode selection for condition B – effect of different use cases

Use case 1: Charge-Mode under Condition B

\[ e_{2,\text{charge}} \ll e_3 \Rightarrow E_{4,\text{charge}} \text{ is significantly negative} \]

Use case 2: Charging balance neutral mode under condition B

Slight discharge: \( e_2 > e_3 \Rightarrow E_{4,\text{neutral}^+} \text{ is slightly positive} \)
Slight charge: \( e_2 < e_3 \Rightarrow E_{4,\text{neutral}^-} \text{ is slightly negative} \)

Comparison of use case 1 and use case 2 (green: identical, red: difference):

- \( E_1 \)
- \( E_{4,\text{charge}} \) is significantly negative, \( E_{4,\text{neutral}^+} \) is slightly positive, \( E_{4,\text{neutral}^-} \) is slightly negative
- \( C_{\text{condition A}} \)
- \( C_{\text{condition B,charge}} \gg C_{\text{condition A,neutral}} \)
- \( D_e \) and \( D_{av} \)

Effect on weighted electric consumption and weighted fuel consumption:

\[
E_{\text{charge}} = \frac{(D_e \cdot E_1) + (D_{av} \cdot E_{4,\text{charge}})}{D_e + D_{av}} \quad <<
\]

\[
C_{\text{charge}} = \frac{(D_e \cdot C_{\text{condition A}}) + (D_{av} \cdot C_{\text{condition B,charge}})}{D_e + D_{av}} \quad >>
\]

Neutral: Intention of R83/101 legislation (also intention of WLTP)

\[
E_{\text{neutral}} = \frac{(D_e \cdot E_1) + (D_{av} \cdot E_{4,\text{neutral}^+/^-})}{D_e + D_{av}}
\]

\[
C_{\text{neutral}} = \frac{(D_e \cdot C_{\text{condition A}}) + (D_{av} \cdot C_{\text{condition B,neutral}})}{D_e + D_{av}}
\]
OVV-HEV Certification according to UN-ECE R83/R101
Different use cases for mode selection under condition B

Use Case 1: Charge-Mode

- Fuel Consumption ($C_{charge}$)
- Electric Consumption ($E_{charge}$)
- Battery Charging
- Recharged Electric Energy can be used for upcoming electric driving
- Lower Fuel Consumption
- Higher Electric Consumption

Use Case 2: Neutral Hybrid-Mode

- Fuel Consumption ($C_{neutral}$)
- Electric Consumption ($E_{neutral}$)
- Vehicle Propulsion

Energy used for Vehicle Propulsion in the test
Energy used for Battery Charging in the test (for electric propulsion at later stage)

9 12
BACK UP
Imagine a vehicle with the following mode set up:

- 1 pure electric mode
- Several hybrid modes
  - Intelligent hybrid mode
  - Charging-Balance-Neutral hybrid mode
  - Sport-Mode
  - Hybrid mode which is charging the REESS

None of the columns in 4.1.3. is perfectly fitting

There are arguments for column 4, as – looking at the surface – is not containing the wording “pure electric”, but one could assume that it is covered by the wording “hybrid mode” as the whole line is called “hybrid modes”.

But: Going into column 4 would lead in the case of this vehicle to a mode selection which is reflecting not only the energy used for vehicle propulsion but also the energy used for energy conversion (conversion from fuel into stored electric energy in the REESS)

The next slides will explain the effect on the test results fuel consumption and electric consumption.
OVC-HEV Certification according to UN-ECE R83/R101
Reminder: homologation test procedure

Test procedure for OVC-HEV testing is set up as follows:

- **Range Determination**
  - **Condition A**
    - Charging
    - Discharging
  - **Condition B**
    - Charging
    - Discharging

- **End of Test**
Mode selection for $D_e$-Range determination:

According to UN-ECE R101, Annex 9, Paragraph 4.2.2.1.1.
OVC-HEV Certification according to UN-ECE R83/R101
Mode selection for Condition A and Condition B testing

Test procedure for Condition A and Condition B testing

Mode selection for Condition A and Condition B:
According to UN-ECE R101, Paragraph 4.1.3. and 4.2.1.
OVC-HEV Certification according to UN-ECE R83/R101
Mode selection “legislative text”

Mode selection for Condition A and Condition B:
According to UN-ECE R101, Paragraph 4.1.3. and 4.2.1.

<table>
<thead>
<tr>
<th>Battery state of charge</th>
<th>Switch in position</th>
<th>Switch in position</th>
<th>Switch in position</th>
<th>Switch in position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition A: Fully charged</td>
<td>Hybrid</td>
<td>Hybrid</td>
<td>Hybrid</td>
<td>Most electric hybrid mode**</td>
</tr>
<tr>
<td>Condition B: Min. state of charge</td>
<td>Hybrid</td>
<td>Fuel consuming</td>
<td>Fuel consuming</td>
<td>Most fuel consuming mode***</td>
</tr>
</tbody>
</table>

* For instance: sport, economic, urban, extra-urban position ...
** The hybrid mode which can be proven to have the highest electricity consumption of all selectable hybrid modes when tested in accordance with condition A, to be established based on information provided by the manufacturer and in agreement with the technical service.
*** The hybrid mode which can be proven to have the highest fuel consumption of all selectable hybrid modes when tested in accordance with condition B, to be established based on information provided by the manufacturer and in agreement with the technical service.

Mode selection for Range Determination (for $D_e$-Range):
According to UN-ECE R101, Annex 9, Paragraph 4.2.2.1.1.

4.2.2.1.1. The applicable test sequence and accompanying gear shift prescription, as defined in paragraph 1.4. of Annex 8, is applied on a chassis dynamometer adjusted as described in Appendices 2, 3 and 4 of Annex 4 to Regulation No. 83, until the end of the test criteria is reached.

To determine the electric range ($D_e$) of OVC HEVs equipped with an operating mode switch the same operating mode position, in accordance with Table 4.1.3 and paragraph 4.2.1 of Annex 8 to this Regulation, shall be used as for the determination of $CO_2$ and fuel consumption.

4.2.1. If the electric range of the vehicle, as measured in accordance with Annex 9 to this Regulation, is higher than 1 complete cycle, on the request of the manufacturer, the type 1 test for electric energy measurement may be carried out in pure electric mode, after agreement of the Technical Service. In this case, the values of $M_1$ and $C_1$, in paragraph 4.4. below are equal to 0.
OVC-HEV Certification according to UN-ECE R83/R101
Mode selection for condition B – effect of different uses cases on measured energies

Use case (1.): Charge-Mode under Condition B (vehicle propulsion and conversion)
REESS will be charged significantly under condition \( e_{2,\text{charge}} \)

Recharge of REESS after complete discharge: \( e_3 \)

Result:
\( e_{2,\text{charge}} \ll e_3 \Rightarrow E_4 \) is significantly negative

Use case (2.): Charging balance neutral mode under condition B (only vehicle propulsion)
REESS will slightly charged or discharged but will – more or less – remain on a charging balance neutral level \( e_{2,\text{neutral}} \)

Recharge of REESS after complete discharge: \( e_3 \)

Result of…
- …slight discharge: \( e_2 > e_3 \Rightarrow E_4 \) is slightly positive
- …slight charge: \( e_2 < e_3 \Rightarrow E_4 \) is slightly negative

\[ e_4 = e_2 - e_3 \]
**OV-C-HEV Certification according to UN-ECE R83/R101**

Mode selection for condition B – effect of different use cases

<table>
<thead>
<tr>
<th>Use case 1: Charge-Mode under Condition B</th>
<th>Use case 2: Charging balance neutral mode under condition B</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e_{2,\text{charge}} \ll e_3 \Rightarrow E_4 ) is significantly negative</td>
<td>Slight discharge: ( e_2 &gt; e_3 \Rightarrow E_4 ) is slightly positive</td>
</tr>
</tbody>
</table>
| \[
E_1 = \frac{e_1}{D_{\text{Condition A}}}
\]

is electric consumption under Condition A

| \( E_{4,\text{charge}} = \frac{e_{2,\text{charge}} - e_3}{D_{\text{Condition B}}} \) is electric consumption under Condition B (in use case 1) | Slight charge: \( e_2 < e_3 \Rightarrow E_4 \) is slightly negative |
| \[
C_{\text{condition A}}
\]

is fuel consumption under Condition A

| \( C_{\text{condition B,charge}} \) is fuel consumption under Condition B (in use case 1) | \[
E_4_{\text{neutral}} = \frac{e_{2,\text{neutral}} - e_3}{D_{\text{Condition B}}}
\]

is electric consumption under Condition B (in use case 2)

| \( D_e \) is range driven under pure electric mode | \( D_e \) is range driven under pure electric mode |
| \( D_{\text{av}} \) is 25km (assumed distance between two battery recharges) | \( D_{\text{av}} \) is 25km (assumed distance between two battery recharges)
OVC-HEV Certification according to UN-ECE R83/R101
Mode selection for condition B – effect of different uses cases

Use case 1: Charge-Mode under Condition B

| $e_{2,\text{charge}} \ll e_3 \Rightarrow E_{4,\text{charge}}$ is significantly negative |

Comparison of use case 1 and use case 2 (green: identical, red: difference):

- $E_1$

- $E_{4,\text{charge}}$ is significantly negative, $E_{4,\text{neutral}+}$ is slightly positive, $E_{4,\text{neutral}−}$ is slightly negative

- $C_{\text{condition } A}$

- $C_{\text{condition } B,\text{charge}} \gg C_{\text{condition } A,\text{neutral}}$

- $D_e$ and $D_{av}$

Effect on weighted electric consumption and weighted fuel consumption:

$E_{\text{charge}} = \frac{(D_e \cdot E_1) + (D_{av} \cdot E_{4,\text{charge}})}{D_e + D_{av}}$

$C_{\text{charge}} = \frac{(D_e \cdot C_{\text{condition } A}) + (D_{av} \cdot C_{\text{condition } B,\text{charge}})}{D_e + D_{av}}$

$E_{\text{neutral}} = \frac{(D_e \cdot E_1) + (D_{av} \cdot E_{4,\text{neutral}+/−})}{D_e + D_{av}}$

$C_{\text{neutral}} = \frac{(D_e \cdot C_{\text{condition } A}) + (D_{av} \cdot C_{\text{condition } B,\text{neutral}})}{D_e + D_{av}}$

Use case 2: Charging balance neutral mode under condition B

| Slight discharge: $e_2 > e_3 \Rightarrow E_{4,\text{neutral}+}$ is slightly positive |
| Slight charge: $e_2 < e_3 \Rightarrow E_{4,\text{neutral}−}$ is slightly negative |

Use case 2: Charging balance neutral mode under condition B

Slight discharge: $e_2 > e_3 \Rightarrow E_{4,\text{neutral}+}$ is slightly positive
Slight charge: $e_2 < e_3 \Rightarrow E_{4,\text{neutral}−}$ is slightly negative