Overview of the Correlation and CO2MPAS Process


Ispra, 15/05/2017
WLTP Test Data → Input CO₂MPAS GUI → TA data – NEDC DV – TA Doc. → TA Report

Yes → DF & VF → NEDC TA

No – Accept DV, Add Hash in TA doc → Physical NEDC Test

NEDC TA

WLTP & NEDC sim. data → Reports (Summary, Dice)

WLTP (prediction) & NEDC Test simulation → Final Engine - Vehicle model setup

Engine - CO₂ model calibration / Instantaneous samples

Initial Engine - CO₂ model setup → Engine - CO₂ model calibration / Instantaneous samples

CO₂та > 0.96

CO₂та > 0.96

Initial Engine - CO₂ model setup → Engine - CO₂ model calibration / Instantaneous samples

WLTP CO₂ Improving?

Yes → Engine data. update

No → WLTP CO₂ Improving?

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No → Initial Engine - CO₂ model setup

Engine - CO₂ model setup → Engine data. update

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WLTP CO₂ Improving?
CO2MPAS Report

• CO2MPAS detailed report contains all input/output data, charts, summarized results.
• Two important tabs for TA process in that report are:
  1. OUTPUT REPORT and
  2. DICE REPORT
### CO2MPAS version 1.5.0rc0
### Date/Time 2017/04/06 12:20:06
### Type approval mode False

**NEDC Average Specific CO2 Emissions**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEDC CO2 declared value</td>
<td>124.40</td>
<td>g/km</td>
</tr>
<tr>
<td>NEDC CO2MPAS simulated</td>
<td>122.06</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2MPAS deviation</td>
<td>-1.88</td>
<td>%</td>
</tr>
</tbody>
</table>

*K factor - corrected

**NEDC CO2MPAS CO2 Emissions**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2MPAS simulated NEDC</td>
<td>122.06</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2MPAS simulated UDC</td>
<td>129.52</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2MPAS simulated EUDC</td>
<td>117.74</td>
<td>g/km</td>
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</table>

**Fuel Type**

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<tr>
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<tbody>
<tr>
<td>diesel</td>
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</tbody>
</table>

**Engine Capacity**

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>1596.00 cc</td>
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</table>

**Gearbox type**

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<tr>
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<tbody>
<tr>
<td>manual</td>
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<td></td>
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</table>

**Turbo engine**

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>TRUE</td>
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</tbody>
</table>

**alternator_model score**

<table>
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<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
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</thead>
<tbody>
<tr>
<td>11.90</td>
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<td></td>
</tr>
</tbody>
</table>

**at_model score**

<table>
<thead>
<tr>
<th></th>
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<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**clutch_torque_converter_model score**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.91</td>
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</tbody>
</table>

**co2_params score**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td></td>
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</tr>
</tbody>
</table>

**engine_cold_start_speed_model score**

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>37.81</td>
<td></td>
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</tr>
</tbody>
</table>

**engine_coolant_temperature_model score**

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<tr>
<th></th>
<th>Vehicle H</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**engine_speed_model score**

<table>
<thead>
<tr>
<th></th>
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<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**start_stop_model score**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CO2MPAS deviation**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NEDC Inputs**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>89.10</td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td>0.8790</td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>0.0387</td>
<td></td>
</tr>
<tr>
<td>Inertia</td>
<td>1590.0</td>
<td></td>
</tr>
</tbody>
</table>

**WLTP Inputs**

<table>
<thead>
<tr>
<th></th>
<th>Vehicle H</th>
<th>Vehicle L</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>101.90</td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td>0.8620</td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>0.0393</td>
<td></td>
</tr>
<tr>
<td>Test Mass</td>
<td>1698.8</td>
<td></td>
</tr>
<tr>
<td>CO2 emission phase Low</td>
<td>141.34</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2 emission phase Medium</td>
<td>128.25</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2 emission phase High</td>
<td>121.60</td>
<td>g/km</td>
</tr>
<tr>
<td>CO2 emission phase Extra-High</td>
<td>153.37</td>
<td>g/km</td>
</tr>
</tbody>
</table>
Output Report

1. If CO2MPAS deviation ≤4% OEM declared NEDC CO2 value is accepted;

2. If CO2MPAS deviation >4% OEM has option to accept new value or to request physical test.
From OUTPUT REPORT phase-specific CO2 values should be calculated

\[ NEDC \ CO_{2,p,H} = NEDC \ CO_{2,p,H,c} \cdot CO_{2,AF,H} \]

\( CO_{2,AF} \) is adjustment factor and ratio between final combined NEDC CO\(_2\) (declared, CO2MPAS) and CO2MPAS simulated value.
For each WLTP interpolation family this file should be sent to a functional mailbox – as a result random number will be received (from 0 to 99).
Random Number

**SCENARIO A**
- CO2MPAS DEVIATION ≤4%
- DV ACCEPTED

**SCENARIO B**
- CO2MPAS DEVIATION >4%
- CO2MPAS ACCEPTED

**DICE REPORT SENT**
- RN 0-89
  - END TA PROCESS
- RN 90-94
  - 1 NEDC-L TEST
- RN 95-99
  - 1 NEDC-H TEST
Random Number

SCENARIO C

CO2MPAS DEVIATION >4%

PHYSICAL NEDC TESTING

TEST 1

TEST 2

TEST 3

DICE REPORT SENT

NEGLECT RN RECEIVED
## Random Testing

<table>
<thead>
<tr>
<th>Only in cases where CO2MPAS was used to confirm declared value there is 10% of chance for performing one random physical test.</th>
</tr>
</thead>
<tbody>
<tr>
<td>From this test <strong>Verification Factor</strong> and <strong>Relative Deviation</strong> should be recorded in TA certificate and CoC.</td>
</tr>
<tr>
<td><strong>Verification Factor VF</strong> is used to check accuracy of the input data (fuel saving gear, start-stop activation time, and BERS). In case of non conformity it shall be set to 1.</td>
</tr>
<tr>
<td><strong>Relative Deviation De</strong> is deviation between measured and OEM declared value</td>
</tr>
</tbody>
</table>

\[
De = \frac{RT_r - DV}{DV}
\]
In the following slides,

- Start-Stop Activation Time
- Fuel saving for automatic vehicles
- Brake Energy Recuperation System

will be clarified with specific methods in real examples.

CO$_2$MPAS team will support you and try to find the solution if you face any doubts about the model and its usage.
Is the Start-Stop activation time declared correctly?

- Identify from random NEDC test when the first Start-Stop occurred from the measured engine speed signal (RPM=0 for the first time).
- Then, considering the start-stop activation time the above must apply:

\[ t_{\text{declared}} \geq t_{\text{measured}} \]
FUEL SAVING FOR AT

- Setting it to 1 allows CO₂MPAS to use a higher gear at constant speed driving than when in transient conditions, resulting in a reduction of fuel consumption;
- **How to check**: Plotting the measured and the simulated signals you may see a which case follows better the original measured RPM signal.

![Wrong Input](image1.png)  ![Correct Input](image2.png)
BERs

Setting it to 1 means that the vehicle is equipped with any kind of break energy recuperation technology or regenerative breaking;

- You should check in parallel the acceleration signal and the battery current. When the vehicle brakes, the acceleration is negative.
- At the periods of breaking (Acceleration < 0), you will observe positive peaks in the battery signal.
Correlation and CO₂MPAS Process flow chart

WLTP Test Data

Input CO₂MPAS GUI


Yes

Yes

No

WLTP Test Data

Initial Engine - CO₂ model setup

Engine - CO₂ model calibration / Instantaneous samples

WLTP CO₂ Improving?

Yes - Engine data. update

Engine - CO₂ model trimming / WLTP bag values

Generic Values Selection

Sub models calibration
(Eng. Temp., RPM, G/box, Clutch-TC, Power)

Final Engine -Vehicle model setup

WLTP (prediction) & NEDC Test simulation

WLTP & NEDC sim. data

Reports (Summary, Dice)

TA Report

DF & VF

Physical NEDC Test

NEDC TA

CO₂MPAS

Yes

No

CACO₂ ≥ 0.96

Dice report emailed to Timestamp Server

Accept DV, Add Hash in TA doc

No - Accept DV, Add Hash in TA doc

NEDC to be tested?
Technologies not covered with CO2MPAS

- Physical NEDC measurements shall be used instead of CO2MPAS in case of HEVs (both OVC-HEVs and NOVC-HEVs)
- However, other provisions set out in Annex I regarding the physical testing shall be respected, in particular:
  1. Calculation of NEDC RLs and inertia;
  2. Number of tests and interpretation of results; and
  3. Calculation of CO2 and FC attributed to individual vehicles in the NEDC interpolation family
Stay in touch

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**LinkedIn:** european-commission-joint-research-centre

**YouTube:** JRC Audiovisuals

**Vimeo:** Science@EC

[https://co2mpas.io](https://co2mpas.io)

Jrc-co2mpas@ec.europa.eu
FUEL SAVING FOR AT

- **Second option to check:** In case that it is still difficult to visually verify if in a specific automatic vehicle this technology applies, you shall calculate the mean error between the measured and the simulated engine_speed vector for the steady state parts of UDC and EUDC:

\[
\text{error} = \frac{1}{n} \sum_{i=0}^{n} (RPM_{\text{measured}}[i] - RPM_{\text{simulated}}[i])
\]

If the mean error is higher than 0, the fuel saving gear is likely not to be present in the vehicle.