Annex 8

Pure and hybrid electric vehicles

1. General requirements

In the case of testing NOVC-HEV and OVC-HEV vehicles, Appendix 2 to this Annex replaces Appendix 2 of Annex 6.

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.

1.2. Electric energy consumption and range testing

Parameters, units and accuracy of measurements shall be as in Table A8/1.

Table A8/1
Parameters, units and accuracy of measurements

Parameter	*Units*	*Accuracy*	*Resolution*
Electrical energy (1)	Wh	± 1 per cent	0.001 Wh(2)
Electrical current	A	± 0.3 per cent FSD or ± 1 per cent of reading (3,4)	0.01 A

(1) Equipment: static meter for active energy.
(2) AC watt-hour meter, Class 1 according to IEC 62053-21 or equivalent.
(3) Whichever is greater.
(4) Current integration frequency 10 Hz or more.

1.3. Emission and fuel consumption testing

Parameters, units and accuracy of measurements shall be the same as those required for conventional combustion engine-powered vehicles as found in~~of~~ Annex 5 (test equipment and calibrations).

1.4. Measurement units and presentation of results

The accuracy of measurement units and the presentation of the results shall follow the indications given in Table A8/2.

Comment [DTF1]:
Iddo Suggestion:
This should then also be stated in Appendix 2 of Annex 6 (see the @3 remark there)

DTF:
Agreed; Text Proposal for Annex 6 Appendix 2:
1. General: Add:
In the case of testing NOVC-HEV and OVC-HEV vehicles, Appendix 2 and Appendix 3 of Annex 8 replaces Appendix 2 of Annex 6

Table A8/2
Accuracy of measurement units and presentation of the results

Parameter	*Units*	*Communication of test result*
AER, AERcity	km	Rounded to nearest whole number
EAER	km	Rounded to nearest whole number
R_{CDA}	km	Rounded to nearest whole number
R_{CDC}	km	Rounded to nearest whole number
Distance	km	Rounded to nearest whole number; for calculation purposes: 0.1 km
Electric energy consumption	Wh/km	Rounded to nearest whole number
NEC	Wh	Rounded to first decimal place
NEC ratio	per cent	Rounded to first decimal place
E_{AC} recharge ~~E~~ energy from the grid	Wh	Rounded to nearest whole number
FC correction factor	l/100 km/(Wh/km)	Rounded to 4 significant digits
CO_2 correction factor	g/km/(Wh/km)	Rounded to 4 significant digits
Utility factor		Rounded to 3 decimal places

1.5. Type 1 test cycles to be driven according to Table A8/3.

1.5.1. All OVC-HEVs, NOVC-HEVs and PEVs with and without driver-selectable operating modes shall be classified as Class 3 vehicles.

1.5.1.1. OVC-HEV and PEV

1.5.1.1.1. WLTC test

1.5.1.1.1.1. Class 3a vehicles shall drive a cycle consisting of a low phase (Low_3), a medium phase ($Medium_{3-1}$), a high phase ($High_{3-1}$) and an extra high phase (Extra $High_3$).

1.5.1.1.1.2. Class 3b vehicles shall drive a cycle consisting of a low phase (Low_3), a medium phase ($Medium_{3-2}$), a high phase ($High_{3-2}$) and an extra high phase (Extra $High_3$).

1.5.1.1.1.3. At the option of the Contracting Party, the Extra $High_3$ phase may be excluded.

1.5.1.1.2. WLTC city test

1.5.1.1.2.1. Class 3a vehicles shall drive a cycle consisting of a low phase (Low_3) and a medium phase ($Medium_{3-1}$)

1.5.1.1.2.2. Class 3b vehicles shall drive a cycle consisting of a low phase (Low_3) and a medium phase ($Medium_{3-2}$)

1.5.1.2. NOVC-HEV

1.5.1.2.1. WLTC test

1.5.1.2.1.1. Class 3a vehicles shall drive a cycle consisting of a low phase (Low_3), a medium phase ($Medium_{3-1}$), a high phase ($High_{3-1}$) and an extra high phase ($Extra\ High_3$).

1.5.1.2.1.2. Class 3b vehicles shall drive a cycle consisting of a low phase (Low_3), a medium phase ($Medium_{3-2}$), a high phase ($High_{3-2}$) and an extra high phase ($Extra\ High_3$).

1.5.1.2.1.3. At the option of the Contracting Party, the Extra $High_3$ phase may be excluded.

Table A8/3
Test matrix

		WLTP		*WLTP city*
		AER, E_{AC} If required: Criteria Emissions, FC, CO_2, ~~AER~~, EAER, R_{CDC}, R_{CDA}, ~~E_{AC}~~	*Criteria Emissions, FC, CO_2*	*AERcity, E_{AC}city*
		Charge-depleting	*Charge-sustaining*	*Charge-depleting*
OVC-HEV	Class 3a	$Low_3 + Medium_{3-1} + High_{3-1} + (ExtraHigh_3)$	$Low_3 + Medium_{3-1} + High_{3-1} + (ExtraHigh_3)$	$Low_3 + Medium_{3-1}$
	Class 3b	$Low_3 + Medium_{3-2} + High_{3-2} + (ExtraHigh_3)$	$Low_3 + Medium_{3-2} + High_{3-2} + (ExtraHigh_3)$	$Low_3 + Medium_{3-2}$
NOVC-HEV	Class 3a	--	$Low_3 + Medium_{3-1} + High_{3-1} + (ExtraHigh_3)$	--
	Class 3b	--	$Low_3 + Medium_{3-2} + High_{3-2} + (ExtraHigh_3)$	--
PEV	Class 3a	$Low_3 + Medium_{3-1} + High_{3-1} + (ExtraHigh_3)$	--	$Low_3 + Medium_{3-1}$
	Class 3b	$Low_3 + Medium_{3-2} + High_{3-2} + (ExtraHigh_3)$	--	$Low_3 + Medium_{3-2}$

1.6. OVC-HEVs. NOVC-HEVs and PEVs with manual transmissions

OVC-HEVs, NOVC-HEVs and PEVs shall be driven according to the manufacturer's instructions, as incorporated in the manufacturer's handbook of production vehicles and indicated by a technical gear shift instrument.

Comment [DTF2]:
Dr. Tappe:
Not all values are valid for PEV

DTF:
Add "if required"

Comment [SMD3]: OPEN POINT.
02.09.2014: Question from I. Riemersma: GSIs (= technical gear shift instrument) are not included in the GTR but rather the shift points described in Annex 2 are to be used. This point to be discussed in the appropriate meeting.

Comment [SMD4]: 12.09.2014:
Deadline for expert comments: 31.10.2014.

Comment [DTF5]:
Dr. Tappe:
according to numbering systematic should here be a headline

MaN:
agreed, task for DC but already changed as possible proposal

2. ~~REESS~~ Vehicle~~P~~ preparation prior to type approval procedure

2.1. For all OVC-HEVs, NOVC-HEVs, and PEVs with and without driver-selectable operating modes, the following shall apply:

(a) Without prejudice to the requirements of paragraph 1.2.3.3. of Annex 6, the vehicles tested to this Annex must have been driven at least 300 km with those batteries installed in the test vehicle;

(b) If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the vehicle ~~car~~ manufacturer in order to keep the temperature of the REESS in its normal operating range. The manufacturer shall provide evidence ~~manufacturer's agent shall be in a position to demonstrate~~ that the thermal management system of the REESS is neither disabled nor reduced.

Comment [DTF6]:
MaN:
Clarifying that it is not meant to prepare the REESS for the test.

Comment [SMD7]: 11.04.2014: EV group confirms “shall”.

Comment [DTF8]:
MaN:
Has to be checked!!!!

3. Test procedure

3.1. General requirements

3.1.1. For all OVC-HEVs, NOVC-HEVs, and PEVs with and without driver-selectable operating modes, the following shall apply where applicable:

3.1.1.1. Vehicles shall be tested according to the test cycles described in paragraph 1.5. of this Annex.

~~Vehicles shall be conditioned, soaked and tested according to the test procedures applicable to vehicles powered solely by a combustion engine described in Annex 6 to this gtr unless modified by this Annex.~~

3.1.1.2. If the vehicles cannot follow the speed trace, the acceleration control shall be fully activated until the required speed trace is reached again. Power to mass calculations ~~and classification methods~~ shall not apply to these vehicle types.

3.1.1.3. The vehicle shall be started by the means provided for normal use to the driver.

3.1.1.4. Exhaust emission compounds sampling and electricity measuring shall begin for each test cycle before or at the initiation of the vehicle start up procedure and end on conclusion of each test cycle.

3.1.1.5. Exhaust ~~E~~emission~~s~~ compounds shall be ~~sampled and~~ analysed for each individual ~~WLTC~~ test cycle phase when the combustion engine starts consuming fuel.

3.1.2. Forced cooling as per paragraph 1.2.7.2. of Annex 6 shall apply only for the charge-sustaining type 1 test of OVC-HEVs according to paragraph 3.2. of this Annex and for ~~the~~ testing of NOVC-HEVs according to paragraph 3.3. of this Annex.

3.2. OVC-HEV, with and without driver-selectable operating modes

3.2.1. Vehicles shall be tested under charge-depleting (CD) and charge-sustaining (CS) conditions ~~according to the cycles described in paragraph 1.5.1.1.1. of this Annex~~.

3.2.2. Vehicles may be tested according to four possible test sequences:

3.2.2.1. Option 1: charge-depleting type 1 test with no subsequent charge-sustaining type 1 test. ~~charge-depleting test with a subsequent charge-sustaining test (CD + CS test).~~

3.2.2.2. Option 2: charge-sustaining type 1 test with no subsequent charge-depleting type 1 test. ~~charge-sustaining test with a subsequent charge-depleting test (CS + CD test).~~

3.2.2.3. Option 3: charge-depleting type 1 test with a subsequent charge-sustaining type 1 test. ~~charge-depleting test with no subsequent charge-sustaining test (CD test).~~

3.2.2.4. Option 4: charge-sustaining type 1 test with a subsequent charge-depleting type 1 test. ~~charge-sustaining test with no subsequent charge-depleting test (CS test).~~

Comment [DTF9]:
MaN:
Is valid for all kind of vehicles, so it is a general requirement

Comment [DTF10]:
MaN: makes no sense here…

Added at:
3.2.5.3.1. and 3.3. of this Annex

Comment [DTF11]:
Dr. Tappe:
must follow speed trace, if necessary acc. pedal fully pressed

DTF:
Wording is correct

Comment [DTF12]:
Need consistant wording for "criteria emissions" within GTR.
Question if there is a need to distinguish between "emissions" and PM/PN?

Comment [DTF13]:
Dr. Tappe:
ok for gaseous emissions, but what about PM, PN ?

DTF:
Yes, wording is correct (see R83 OVCrange)

Comment [DTF14]:
Dr. Tappe:
why not " **is** consuming fuel"

DTF:
Task for DC

Comment [DTF15]:
Iddo:
Suggestion:
To avoid that this contradicts par. 3.1.1.4 above it is recommended to leave this part of the sentence out. Alternatively, it is integrated in 3.1.1.4.

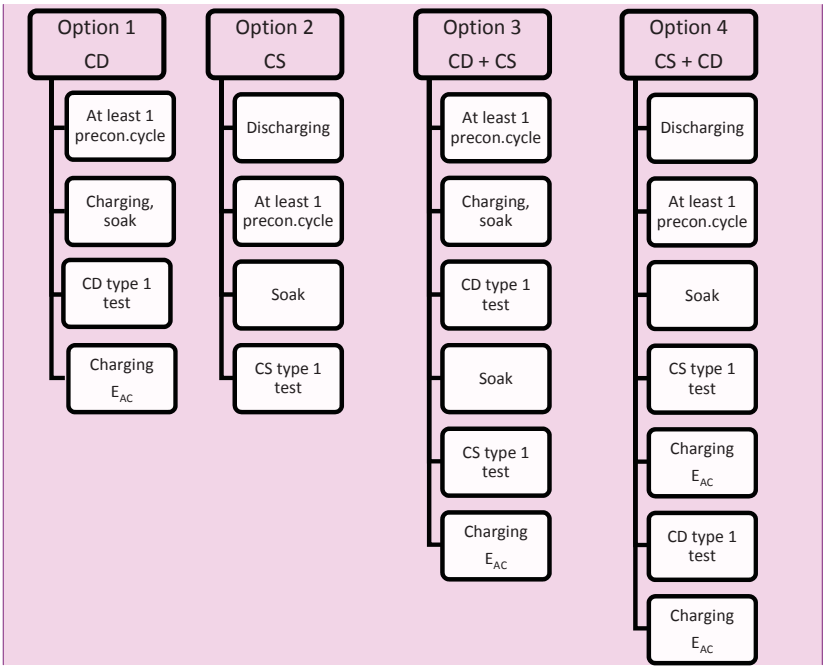
ACEA:
Paragraph needed for OVC-HEV. Measurement only needed in cd cycles when ICE is running. No need to sample emissions in cycles with pure electric operation.

Text proposal:
For OVC-HEV cd-test, exhaust emissions may only be sampled and analysed for each individual WLTC phase when the combustion engine is consuming fuel.

Comment [DTF16]:
Dr. Tappe:
forced cooling only for cs mode

DTF:
Forced cooling as per paragraph 1.2.7.2. of Annex 6 shall apply only for the charge sustaining test.

Figure A8/1
Possible test sequences in case of OVC-HEV testing



3.2.3. The driver-selectable operating mode shall be set as described in the following tests (Option 1 to Option 4) and according to the applicable test conditions. ~~The driver selectable operating mode switch shall be set according to the test conditions.~~

3.2.4. Charge-depleting ~~(CD)~~ type 1 test with no subsequent charge-sustaining ~~(CS)~~ type 1 test (option 1~~3~~)

The test sequence according to option 1, as described in the subparagraphs of 3.2.4., is visualized in Appendix 1, §1.1.
Figure A8.App1a/1 also shows the profile of the REESS state of charge during the test sequence.

3.2.4.1. Preconditioning

The vehicle shall be prepared according to the procedures in Appendix 4, paragraph 2.2. of this Annex.

3.2.4.2. Test conditions

3.2.4.2.1. The test shall be carried out with a fully charged REESS according the charging requirements as described in paragraph 2.2.5. of Appendix 4 to this Annex.

3.2.4.2.2. Operation mode selection

3.2.4.2.2.1. The charge-depleting type 1 test shall be performed in the highest electric energy consumption mode that best matches the driving cycle.~~by using the most electric energy consuming mode that best matches the driving cycle.~~ If

Comment [DTF17]: "Test" replaced by "Type 1 test"

➔Justification: clear and understandable (bijective) description

Comment [DTF18]: Delete switch.

MaN has to check for more switches

Comment [DTF19]: proposal for text modification

Comment [DTF20]:
Dr. Tappe:
Insert a"as described below"

DTF:
Proposal for rewording (see DTF473)

the vehicle cannot follow the trace, other installed propulsion systems shall be used to allow the vehicle to best follow the cycle.

3.2.4.2.2.2. Dedicated driver-selectable modes such as "mountain mode" or "maintenance mode" which are not intended for normal daily operation but only for special limited purposes shall not be considered for charge-depleting condition testing.

3.2.4.3. Charge-depleting ~~T~~type 1 test procedure

3.2.4.3.1. The charge-depleting type 1 test procedure shall consist of a number of consecutive test cycles, each followed by a soak period of no more than 30 minutes ~~(maximum of 30 minute soak period~~ until charge-sustaining operation is achieved.

3.2.4.3.2. During soaking between individual ~~WLTCs~~ test cycles, the key ~~switch~~ shall be in the "off" position, and the REESS shall not be recharged from an external electric energy source. The RCB instrumentation shall not be turned off between test cycle phases. In the case of ampere-hour meter measurement, the integration shall remain active throughout the entire test until the test is concluded.

Restarting after soak, the vehicle shall be operated in the ~~required~~ driver-selectable operation mode according to paragraph 3.2.4.2.2 of this Annex.

3.2.4.3.3. In deviation from paragraph 5.3.1. of Annex 5 and without prejudice to paragraph 5.3.1.2.~~5.3.1.3.~~, analysers may be calibrated and zero checked before and after the charge-depleting test.

3.2.4.4. End of the charge-depleting type 1 test

The end of the charge-depleting type 1 test is considered to have been reached at the end of ~~WLTC~~ test cycle n ~~(defined as the transition cycle)~~ when the break-off criterion (according to paragraph 3.2.4.5 of this Annex) during test cycle n + 1 is reached for the first time. The test cycle n is defined to be the transition cycle.

3.2.4.4.1. For vehicles without a charge-sustaining capability on the complete ~~WLTC~~test cycle, the end of the charge-depleting type 1 test is reached by an indication on a standard on-board instrument panel to stop the vehicle, or when the vehicle deviates from the prescribed driving tolerance for ~~four~~ 4 seconds or more. The acceleration controller shall be deactivated. The vehicle shall be braked to a standstill within 60 ~~sixty~~ seconds.

3.2.4.5. Break-off criterion

3.2.4.5.1. The break-off criterion has to be validated for each driven test cycle

3.2.4.5.~~2~~1. The break-off criterion for the charge-depleting type 1 test is reached when the relative net energy change, NEC_i, as shown in the equation below is less than 4 per cent.

$$NEC_i\ (\%) = \frac{\Delta E_{REESS,i}}{E_{cycle} \times \frac{1}{3600}}$$

where:

NEC_i is the relative net energy change of the considered test cycle i of the CD type 1 test, per cent;

Comment [DTF21]:
Dr. Tappe:
already required in § 3.1.1.2., with other wording

DTF:
Not about the acceleration pedal but about the mode. Needs to be kept as it is!!!

Comment [DTF22]:
Observation of Iddo:
The most electric consuming mode is not necessarily the most suitable one for driving the WLTC and vice versa, so it needs to be clear what is the predominant requirement.
One possible solution:
Within the modes available to the driver which are suitable for driving the applicable WLTC, the most electric energy consuming mode will be selected.

DTF-answer: … [1]

Comment [DTF23]:
Iddo Suggestion:
To make this more specific, a requirement can be added to the expected use of such a mode, e.g. used less than 1% during the vehicle life

… [2]

Comment [DTF24]:
Iddo Content:
This term is not defined, and it is also not consistent with par. 3.1.1.6 where this is referred to as a propulsion system switch. It is recommended to harmonise the terminology and if possible to define

… [3]

Comment [DTF25]:
Dr. Tappe:
insert “engine”. What about key-less systems ?

DTF:
Wording is correct. Needs to be kept as it is

Comment [DTF26]: Has to be reworked

Comment [DTF27]:
Dr. Tappe:
not consistent with 3.1.1.2. - fully press accelerator pedal

DTF:
Keep at it is

… [4]

Comment [DTF28]:
Dr. Tappe:
is this vehicle classified as HEV ? No test results for cd test ? for incomplete WLTC - how to evaluate criteria pollutant emissions?

… [5]

Comment [DTF29]:
Dr. Tappe:
should be “NEC ratio” – see Table A8/2

DTF:

$\Delta E_{REESS,i}$ is the change of electric energy of all REESS of the considered CD type 1 test cycle i calculated according to equation 7 of paragraph 4.3 of this Annex, Wh;

E_{cycle} is the cycle energy demand of the considered test cycle calculated according to paragraph 5 of Annex 7, Ws;

i is the index number of the considered test cycle

$\frac{1}{3600}$ conversion factor to Wh for the cycle energy demand.

3.2.4.6. REESS charging and measuring electric energy consumption

3.2.4.6.1. The vehicle shall be connected to the mains within 120 minutes after the test cycle n+1 in which the break-off-criterion for ~~conclusion of~~ the charge-depleting t~~T~~ype 1 test is reached for the first time.

The REESS is fully charged when the end of charge criterion (as defined in Annex 8 Appendix 4 §2.2.5.2) is reached.

3.2.4.6.2. The energy measurement equipment, placed before the vehicle charger, shall measure the recharged energy, E_{AC}, delivered from the mains, as well as its duration. Electric energy measurement can be stopped when ~~the state of charge after the CD test is at least equal to the state of charge measured before the CD test. The state of charge can be determined by on board or external instruments~~ the end of charge criterion (as defined in Annex 8 Appendix 4 §2.2.5.2) is reached.

3.2.4.7. Each individual ~~full WLTC~~ test cycle within the charge-depleting type 1 test shall fulfil the applicable exhaust emission limits according to paragraph 1.1.1.2. of Annex 6.

3.2.5. Charge-sustaining type 1~~S~~ test with no subsequent charge-depleting type 1~~CD~~ test (option 2~~4~~)

The test sequence according to option 2, as described in the subparagraphs of 3.2.5., is visualized in Appendix 1, §1.2.
Figure A8.App1a/2 also shows the profile of the REESS state of charge during the test sequence.

3.2.5.1. Preconditioning

The vehicle shall be prepared according to the procedures in paragraph 2.1. of Appendix 4 to this Annex.

3.2.5.2. Test conditions

3.2.5.2.1. Tests shall be carried out with the vehicle operated in charge-sustaining operation condition ~~in which the energy stored in the REESS may fluctuate but, on average, is maintained at a charging neutral balance level while the vehicle is driven.~~ (as defined in 3.3.7)

3.2.5.2.2. Operation mode selection

For vehicles equipped with a driver-selectable operating mode, the charge-sustaining test shall be performed in the charging balance neutral hybrid mode that best matches the target curve.

Comment [DTF30]:
Iddo Observation:
This is not shown in the figure of Appendix 1a

DTF:
There will be a figure added to make it clear

Comment [DTF31]:
Text Proposal:
"… Electric energy measurement can be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4.2.5.2) is reached."

Comment [DTF32]:
Dr. Tappe:
"recharge" ? see Table A8/2

DTF:
"…recharged…"

Comment [DTF33]:
Iddo Observation:
This term is not defined.

Comment [DTF34]:
Iddo Suggestion:
This text probably has to be deleted. It is impossible that the state of charge after the CD test is at least equal to the state of charge before the CD test.
Also note that there cannot be a CS test since option 3 only deals with CD testing

Comment [DTF35]:
Iddo Suggestion:
It is suggested to add accuracy requirements to the determination of state of charge.

Comment [DTF36]:
Text Proposal:
"… Electric energy measurement can be stopped when the end of charge … [6]

Comment [DTF37]:
Iddo Suggestion:
Add the reference to this requirement

DTF: … [7]

Comment [DTF38]: ????

Comment [DTF39]:
Iddo Observation:
This text is double to the definition in section B, par. 3.3.7, and could therefore be left out. … [8]

Comment [DTF40]:
Iddo Suggestion:
which is most suitable for the applicable WLTC instead of best matches the target curve) … [9]

Comment [DTF41]:
Dr. Tappe:
how to determine this ?

ACEA answer: … [10]

~~3.2.5.2.3. The profile of the state of charge of the REESS during different stages of the Type 1 test in CD and CS mode respectively is given in Appendices 1a and 1b.~~

~~3.2.5.2.4. Upon request of the manufacturer and with approval of the responsible authority, the manufacturer may set the start state of charge of the traction REESS for the charge sustaining test.~~

3.2.5.3. Type 1 test procedure

3.2.5.3.1. Vehicles shall be tested according to the test procedures applicable to vehicles powered solely by a combustion engine described in Annex 6 to this GTR.

3.2.5.3.2. If required by paragraph ~~4.2.1.3~~1~~.~~ of Appendix 2 of this Annex, CO_2 mass emission~~s~~ and fuel consumption results shall be corrected~~ according to the RCB correction as described in Appendix 2 of this Annex~~.

3.2.5.3.3~~2~~. The ~~charge sustaining~~ test according to 3.2.5.3.1. of this Annex shall fulfil the applicable exhaust emission limits according to paragraph 1.1.1.2. of Annex 6.

3.2.6. Charge-depleting type 1~~CD~~ test with a subsequent charge-sustaining type 1~~CS~~ test (option 3~~1~~)

The test sequence according to option 3, as described in the subparagraphs of 3.2.6., is visualized in Appendix 1, §1.3. of this Annex.
Figure A8.App1a/3 also shows the profile of the REESS state of charge during this test sequence.

3.2.6.1. For the charge-depleting type 1 test, it shall be followed ~~T~~the procedure~~s for the CD test~~ from paragraph 3.2.4.1. up to and including paragraph 3.2.4.5. of this Annex~~ shall be followed~~.

3.2.6.2. Subsequently, it shall be followed the procedure~~s~~ for the charge-sustaining type 1~~CS~~ test from paragraph 3.2.5.1. up to and including paragraph 3.2.5.3.~~.~~ (except paragraph 2.1.1. to 2.1.4 of Appendix 4~~3.2.5.2.4.~~) ~~3.2.5.2.5.~~) in this Annex~~. shall be followed.~~

3.2.6.3. REESS charging and measuring electric energy consumption

3.2.6.3.1. The vehicle shall be connected to the mains within 120 minutes after the conclusion of the charge-sustaining t~~T~~ype 1 test~~.~~

The REESS is fully charged when the end of charge criterion (as defined in Annex 8 Appendix 4 §2.2.5.2) is reached.

3.2.6.3.2. The energy measurement equipment, placed before the vehicle charger, shall measure the recharged energy, E_{AC}, delivered from the mains, as well as its duration. Electric energy measurement may be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4 §2.2.5.2) is reached.~~the state of charge after the CS test is at least equal to the state of charge measured before the CD test. The state of charge shall be determined by on-board or external instruments.~~

Comment [DTF42]:
Iddo Suggestion
This text seems more appropriate for par 3.2.1 or 3.2.2, especially since Appendix Ia shows the profile for CD mode while 3.2.5 deals only with CS operation.

DTF:
Already done in current GTR version

Comment [DTF43]: MaN: deletion because it is directly under 3.2.5.

Comment [DTF44]:
Iddo Observation:
Since 3.2.5 deals with the CS test, and the preconditioning of the batteries is done accordingly (par. 2.1 of Appendix 2), it is unclear why this option should be given. Check if this paragraph is at the correct place, or if it should be in 3.2.4

MaN:
Belongs to preconditioning of the vehicle and is already described in Appendix 4 of this Annex

Comment [DTF45]: DTF Suggestion:
Deletion because of
1.) Belongs to preconditioning and
2.) is already described in Appendix 4 of this Annex

Comment [DTF46]:
Dr. Tappe:
delete comma, as criteria pollutants are not corrected

Comment [DTF47]:
Iddo Observation:
Par 3.2.5.1 describes the preconditioning for the CS test. Check if that is correct, or if the end of the CD test is the condition at which the CS test can follow imme... [11]

Comment [DTF48]:
Dr. Tappe:
does not exist – is 3.2.5.2.4. meant ?

DTF:
Proposal for ammendment in the text

Comment [DTF49]:
Text Proposal:
"… Electric energy measurement can be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4.2.5.2) is reached."

Comment [DTF50]:
Dr. Tappe:
better "recharge" ?

DTF:
Agreed ... [12]

Comment [DTF51]:
Text Proposal:
"… Electric energy measurement can be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4 §2.2.5.2) is reached."

3.2.7. Charge-sustaining type 1 test with subsequent charge-depleting type 1 test ~~CS test with a subsequent CD test~~ (option 4~~2~~)

The test sequence, as described in the subparagraphs of 3.2.7., is visualized in Appendix 1, §1.4 to this Annex.
Figure A8.App1a/4 also shows the profile of the REESS state of charge during the test sequence.

3.2.7.1. For the charge-sustaining type 1 test, it shall be followed ~~T~~the procedures ~~for the CS test~~ from paragraph 3.2.5.1. to paragraph 3.2.5.3. and paragraph 3.2.6.3.1. of~~in~~ this Annex. ~~shall be followed.~~

3.2.7.2. Subsequently, it shall be followed the procedures for the charge-depleting type 1~~CD~~ test from paragraph 3.2.4.3. to paragraph 3.2.4.7. of this Annex. ~~shall be followed~~.

~~3.2.8. Cycle energy demand~~

~~3.2.8.1. Cycle energy demand of the test vehicle shall be calculated according to paragraph 5 of Annex 7.~~

~~3.2.9. Electric range determination~~

~~3.2.9.1. The charge depleting test procedure as described in paragraph 3.2.4. of this Annex shall apply to electric range measurements.~~

~~3.2.9.2. All-electric range (AER, AERcity)~~

~~3.2.9.2.1. The total distance travelled over the test cycles from the beginning of the charge depleting test to the point in time during the test when the combustion engine starts to consume fuel shall be measured.~~

~~3.2.9.2.2. At the option of the Contracting Party, the determination of AERcity may be excluded.~~

~~3.2.9.3. Equivalent all-electric range (EAER)~~

~~3.2.9.3.1. The range shall be calculated according to paragraph 4.4.1.2. below.~~

~~3.2.9.4. Charge depleting cycle range (R_{CDC})~~

~~3.2.9.4.1. The distance from the beginning of the charge depleting test to the end of the last cycle prior to the cycle or cycles satisfying the break-off criteria shall be measured. This shall include the distance travelled during the transition cycle where the vehicle operates in both depleting and sustaining modes. If the charge-depleting test possesses a transition range, the R_{CDC} shall include those transition cycles or cycles.~~

~~3.2.9.5. Actual charge-depleting range (R_{CDA})~~

~~3.2.9.5.1. The range shall be calculated according to paragraph 4.4.1.4. below.~~

3.3. NOVC-HEV, with and without driver-selectable operating modes

Vehicles shall be conditioned, soaked and tested according to the test procedures applicable to vehicles powered solely by a combustion engine described in Annex 6 to this GTR.

The test sequence as described in the subparagraphs of 3.3., is visualized in Appendix 1, §2.

Comment [DTF52]: Maybe describing/explaining this earlier or leave it out here if/as already explained

Suggestion:
Delete it because already referenced in the formula where the cycle energy demand is used

Comment [DTF53]: Electric range is described in 4.4 of this annex

Comment [DTF54]: Deletion of 3.2.9 because this is topic of Annex 8 Chapter 4

Comment [DTF55]:
There is a reference or paragraph missing describing how the NOVC-HEV has to be preconditioned

Reference would be 3.1.1.1 (?)

Comment [DTF56]:
Structure of chapter 3.3. revised in order to be consistent with 3.1. and 3.2.

Figure A8.App1a/5 also shows the profile of the REESS state of charge during the test sequence.

3.3.1. Preconditioning

Without prejudice of Annex 8 paragraph 3.1.1.1.~~Alternatively,~~ at the request of the manufacturer, the level of the state of charge of the traction REESS for the charge-sustaining test may be set according to manufacturer's recommendation in order to achieve a charge balance neutral charge-sustaining test.

3.3.2. Test Conditions

3.3.2.1. Vehicles shall be tested under charge-sustaining (CS) conditions.~~ according to the cycles described in paragraph 1.5.1.2.1. of this Annex.~~

3.3.2.2. For vehicles equipped with a driver-selectable operating mode, the charge-sustaining type 1 test shall be performed in the charging balance neutral hybrid mode that best matches the target curve

~~Vehicles shall be tested under charge-sustaining (CS) conditions according to the cycles described in paragraph 1.5.1.2.1. of this Annex.~~

~~3.3.2. Vehicle and REESS Conditioning~~

~~3.3.2.1. Alternatively, at the request of the manufacturer, the level of the state of charge of the traction REESS for the charge-sustaining test may be set according to manufacturer's recommendation in order to achieve a charge balance neutral charge-sustaining test.~~

3.3.3. Type 1 test procedure~~Test~~

3.3.3.1. If required by paragraph 1 of Appendix 2 of this Annex, CO_2 mass emission and fuel consumption results shall be corrected.

~~If required by paragraph 4.2.2. of this Annex, CO_2 emissions and fuel consumption results shall be corrected according to the RCB correction described in Appendix 2 to this Annex.~~

3.3.3.2. The charge-sustaining type 1 test shall fulfil the applicable exhaust emission limits according to paragraph 1.1.1.2. of Annex 6.

3.4. PEV, with and without driver-selectable operating modes

The test sequence as described in the subparagraphs of 3.4., is visualized in Appendix 1, §3.

Figure A8.App1a/6 also shows the profile of the REESS state of charge during the test sequence.

3.4.1. Preconditioning

The vehicle shall be prepared according to the procedures in paragraph 3 of Appendix 4 to this Annex.

3.4.2. Test conditions

Comment [DTF57]: Referencing also on Appendix 4?
Check!!!

Comment [DTF58]: Insert here a reference where it is described how the NOVC-HEV has to be preconditioned

Reference would be 3.1.1.1 (?)

Then "alternatively" makes sense

This point has to be reconfirmed!!!

Comment [DTF59]: Insert here a reference where it is described how the NOVC-HEV has to be preconditioned

Reference would be 3.1.1.1 (?)

Then "alternatively" makes sense

Comment [DTF60]:
Dr. Tappe:
No specifications how to perform the type 1 test

Comment [DTF61]:
Dr. Tappe:
delete comma, as criteria pollutants are not corrected

Comment [DTF62]:
Dr. Tappe:
This § not needed here – can be deleted

Comment [DTF63]:
3.3.3.2. added:
To be in line with 3.2.5.3. (CS-test for OVC-HEV)

Comment [DTF64]:
"driver-selectable operating modes " and "driver-selectable operation modes"
➔ Needs to be checked for consistency

3.4.2.1. Vehicles shall be tested under charge-depleting (CD) conditions ~~according to the cycles described in paragraph 1.5.1.1. of this Annex~~.

3.4.2.2. If the vehicle is equipped with a driver-selectable operating mode, the charge-depleting test shall be performed in the highest electric energy consumption mode that best matches the speed trace.

3.4.2.3. The profile of the state of charge of the REESS during different stages of the Type 1 test is given in Appendix 1c.

3.4.3. Type 1 test procedure

3.4.3.1. The test starts with a fully charged traction REESS (according to the PEV REESS preconditioning requirements as described in paragraph 3. of Appendix 4 to this Annex)

3.4.3.2. The test has to be performed by driving consecutive test cycles until the break-off criterion (according to 3.4.3.4.) is reached.

Breaks for the driver and/or operator shall be permitted only between test cycles as described in Table A8/4.

3.4.3.3. From the beginning of the test until the break-off-criterion is reached, the distance and electric energy shall be measured

3.4.3.4. Break-off criterion

The break-off criterion is reached when the vehicle deviates from the prescribed driving tolerance for 4 seconds or more. The acceleration controller shall be deactivated. The vehicle shall be braked to a standstill within 60 seconds.

3.4.3.5. After the standstill (as described in 3.4.3.4.) the vehicle shall be connected to the mains within 120 minutes. The energy measurement equipment, placed before the vehicle charger, shall measure the charge energy, E_{AC}, delivered from the mains as well as its duration. Electric energy measurement may be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4 §3.4.) is reached.

~~3.4.2. The total distance travelled over the test cycles from the beginning of the charge depleting test until the break-off criterioncriteria is reached shall be recorded.~~

~~3.4.3. Breaks for the driver and/or operator shall be permitted only between test cycles as described in Table A8/4.~~

Comment [DTF65]:
Dr. Tappe:
Are there other conditions for PEV ?

Comment [DTF66]:
Check for consistency
"that best matches the target curve"

Comment [DTF67]:
Dr. Tappe suggestion:
Replace by "cannot follow the prescribed driving cycle within the allowed tolerance"

Comment [DTF68]:
Dr. Tappe suggestion:
Replace by "recharged"

Comment [DTF69]:
Duration --> check!

Comment [DTF70]:
Text Proposal:
"… Electric energy measurement can be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4.2.5.2) is reached."

Comment [DTF71]:
Iddo:
Attach:
and is referred to AER in case of WLTC testing respectively AERcity in case of WLTCcity testing

DTF:
Due to the discussion about phase specific values, it is up to the decision if the city cycle is still necessary

Comment [DTF72]: 3.4.2 is now 3.4.3.3

Table A8/4
Breaks for the driver and/or test operator

Distance driven (km)	*Maximum total break time (min)*
Up to 100	10
Up to 150	20
Up to 200	30
Up to 300	60
More than 300	Shall be based on the manufacturer's recommendation

Note: during a break, the propulsion system switch shall be in the "OFF" position.

~~3.4.4. Testing~~

~~3.4.4.1. If the vehicle is equipped with a driver-selectable operating mode, the charge-depleting test shall be performed in the highest electric energy consumption mode that best matches the speed trace.~~

~~3.4.4.2. The measurement of all-electric range AER and electric energy consumption shall be performed during the same test.~~

~~3.4.4.3. All-electric range test~~

~~3.4.4.3.1. The test method shall include the following steps:~~

~~(a) Initial charging of the traction REESS;~~

~~(b) Driving consecutive WLTCs until the break-off criterion is reached and measuring AER;~~

~~(c) Recharging the traction REESS and measuring the electric energy consumption.~~

~~3.4.4.3.1.1. The all-electric range test shall be carried out with a fully charged traction REESS according to the charging requirements as described in paragraph 3. of Appendix 4 to this Annex.~~

~~3.4.4.3.1.2. WLTCs shall be driven and the all-electric range (AER) distance shall be measured.~~

~~3.4.4.3.1.3. The end of the test occurs when the break-off criterioncriteria is reached.~~

~~The break-off criteria criterion shall have been reached when the vehicle deviates from the prescribed driving tolerance for 4four seconds or more. The acceleration controller shall be deactivated. The vehicle shall be braked to a standstill within 60 sixty seconds.~~

~~3.4.4.3.1.4. The vehicle shall be connected to the mains within 120 minutes after the conclusion of the all-electric range AER determination. The energy measurement equipment, placed before the vehicle charger, shall measure the charge energy, E_{AC}, delivered from the mains, as well as its duration. Electric energy measurement may be stopped when the state of charge after the range test is at least equal to the state of charge measured before the range test. The state of charge shall be determined by on-board or external instruments.~~

~~3.4.4.4. All-electric range city (AERcity) test~~

~~3.4.4.4.1. The test method includes the following steps:~~

Comment [DTF73]:
Check for consistency
"that best matches the target curve"

Comment [DTF74]:
Delete this sentence

Justification: there is additional test to determine one of these values, hence both values have to be determined by the type 1 test

(a) Initial charging of the traction REESS;

(b) Driving consecutive WLTC city cycles until the break-off criteria criterion is reached and measuring AERcity;

(c) Recharging the traction REESS and measuring electric energy

3.4.4.4.1.1. The all electric range city test shall be carried out with a fully charged traction REESS according to the charging requirements as described in paragraph 3. of Appendix 4 of this Annex.The initial charging procedure of the traction REESS shall start with a normal charging and the end of charge criteria shall be as defined in paragraph 3.4.4.3.1.5. above and in Appendix 4 of this Annex.

3.4.4.4.1.2. City cycles shall be driven and the all electric range city (AERcity) distance shall be measured.

3.4.4.4.1.3. The end of the test occurs when the break-off criteria criterion is reached according to paragraph 3.4.4.3.1.3. above.

Comment [SMD75]:

Comment [SMD76]: 11.05.2014: Modification to 3.4.4.4.1.1. provided by P. Öhlund.

4. Calculations for hybrid and pure electric vehicles

4.1. Calculations of gaseous and particulate emission compounds

~~Exhaust gases shall be analysed according to Annex 6. All equations shall apply to the considered test cycle.~~

Comment [DTF1]: included in §3.

Comment [DTF2]: What is the meaning of this sentence?
DTF: Proposal is to delete this sentence.

4.1.1. Charge-sustaining mass emission of gaseous and particulate emission compounds for OVC-HEV and NOVC-HEV with and without driver-selectable operating modes

The charge-sustaining mass emission of gaseous emission compounds, except CO_2 mass emission, shall be calculated according to 3.2.1 of Annex 7.

For the calculation of charge-sustaining CO_2 mass emission $M_{CO2,CS}$ the methodology described in Appendix 2 of this Annex shall be used.

The charge-sustaining mass emission of particulate emission shall be calculated according to 3.3 of Annex 7.

The charge-sustaining particle number shall be calculated according to 4. of Annex 7.

4.1.2 Utility factor weighted charge-depleting mass emission of gaseous and particulate emission compounds for OVC-HEV with and without driver selectable operating modes

For the charge-depleting type 1 test only the calculation of the utility factor weighted CO_2 mass emission $M_{CO2,CD}$ is required and shall be calculated as follows:

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

where:

$M_{CO2,CD}$ is the utility factor weighted charge-depleting CO_2 mass emission, g/km;

$M_{CO2,CD,j}$ is the CO_2 mass emission determined according to 3.2.1. of Annex 7 of phase j of the CD type 1 test, g/km;

UF_j is the utility factor of phase j according to Appendix 5 of this Annex;

j is the index number of the considered phase;

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

4.1.3.~~1.2.~~ Utility factor weighted mass emission of gaseous and particulate emission compounds of CD and CS type 1 test for OVC-HEV with and without driver-selectable operating modes

The utility factor weighted mass emissions~~-~~ of gaseous and particulate emission compounds from the charge-depleting and charge-sustaining type 1 test ~~results~~ shall be calculated using the following equation:

$$M_{i,weighted} = \sum_{j=1}^{k}(UF_j \times M_{i,CD,j}) + (1 - \sum_{j=1}^{k} UF_j) \times M_{i,CS} \quad (2)$$

where:

$M_{i,weighted}$ is the utility factor weighted mass emission of gaseous or particulate emission compound i, g/km;

i is the index of the considered gaseous or particulate emission compound;

UF_j is the ~~fractional~~ utility factor ~~of the j^{th}~~ of phase j according to Appendix 5 of this Annex;

$M_{i,CD,j}$ is the mass emission of the gaseous emission compound i determined according to paragraph 3.2.1. of Annex 7 or of the particulate emission determined according to paragraph 3.3. of Annex 7 of phase j of the CD type 1 test, g/km;

$M_{i,CS}$ is the charge-sustaining mass emission of gaseous or particulate emission compound i for the CS type 1 test according to paragraph 4.1.1. of this Annex, g/km;

j is the index ~~number~~ of the considered phase~~s up to the end of the transition cycle n~~;

k is the number of phases driven until the end of ~~transition cycle n~~transition cycle n according to paragraph 3.2.4.4. of this Annex.

The utility factor weighted particle number emission from the charge-depleting and charge-sustaining type 1 test shall be calculated using the following equation:

$$N_{weighted} = \sum_{j=1}^{k}(UF_j \times N_{CD,j}) + (1 - \sum_{j=1}^{k} UF_j) \times N_{CS} \quad (3)$$

where:

$N_{weighted}$ is the utility factor weighted particle number, particles per kilometre;

UF_j is the utility factor of phase j according to Appendix 5 of this Annex;

$N_{CD,j}$ is the particle number determined according to paragraph 4. of Annex 7 of phase j of the CD type 1 test, particles per kilometre;

N_{CS} is the particle number determined according to paragraph 4.1.1. of this Annex for the CS type 1 test, g/km;

j is the index of the considered phase;

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

~~4.1.2. NOVC-HEV with and without driver selectable operating modes~~

~~4.1.2.1. Exhaust emissions shall be calculated as required for conventional vehicles according to Annex 7.~~

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~~4.1.2.2. The charging balance correction (RCB) calculation is not required for the determination of emissions compounds.~~

4.2. Calculation of fuel consumption ~~calculations~~

~~Exhaust gases shall be analysed according to Annex 6.~~

4.2.1. Charge-sustaining fuel consumption for OVC-HEV and NOVC-HEV with and without driver-selectable operating modes

The charge-sustaining fuel consumption shall be calculated as described in Appendix 2 if this Annex.

~~4.2.1.1. eighted charge-depleting CO_2 emissions~~

~~The CO_2 at charge-depleting, $CO_{2,CD}$ shall be calculated as follows:~~

~~$CO_{2,CD}$ = (3)~~

~~where:~~

~~$CO_{2,CD}$ is the utility factor mass of CO_2 emissions during charge-depleting mode, g/km;~~

~~$CO_{2,CD,j}$ are the CO_2 emissions measured during the j^{th} charge-depleting phase, g/km;~~

~~UF_j the driving cycle and phase specific utility factor according to Appendix 5 this Annex;~~

~~j is the index number of each phase up to the end of the transition cycle n;~~

~~k is the number of phases driven up to the end of transition cycle n.~~

4.2.2. Utility factor weighted charge-depleting fuel consumption for OVC-HEV with and without driver-selectable operating modes

The utility factor weighted charge-depleting fuel consumption ~~values,~~ FC_{CD}, ~~at charge-depleting~~ shall be calculated as follows:

$$FC_{CD} = \frac{\sum_{j=1}^{k}(UF_j \times FC_{CD,j})}{\sum_{j=1}^{k} UF_j} \qquad (4)$$

where:

FC_{CD} is the utility factor weighted charge-depleting fuel consumption ~~charge-depleting mode~~, l/100 km;

$FC_{CD,j}$ is the fuel consumption ~~measured~~ determined according to paragraph 6. of Annex 7 of phase j of the CD type 1 test, l/100 km;

UF_j is the ~~driving cycle and phase specific~~ utility factor of phase j according to Appendix 5 of this Annex;

j is the index number of ~~each~~ the considered phase ~~up to the end of the transition cycle n~~;

Comment [DTF3]: content for §3. of this Annex

Comment [DTF4]: see 4.1.2

Comment [SMD5]: OPEN POINT: 19.05.2014: Are these weighted emissions or not? EV experts have been contacted.

Comment [SMD6]: EXPERT PROPOSAL: 20.05.2014: Kobayashi-san says "Weighted" means "calculated with Utility Factor".
Therefore "weighted" is necessary.
Comments from any other expert are welcome.

Comment [SMD7]: 12.06.2014: Deadline for expert comments: 31.08.2014.

Comment [SMD8]: CONFIRMATION: 12.09.2014.

Comment [SMD9]: OPEN POINT: 19.05.2014: Are these weighted fuel consumption values or not? EV experts have been contacted.

Comment [DTF10]: Yes. This is the weighted fuel consumption but only the charge depleting test is regarded. This is the reason why this value is normalized in the equation.

Comment [SMD11]: EXPERT PROPOSAL: 20.05.2014: Kobayashi-san says "Weighted" means "calculated with Utility Factor".
Therefore "weighted" is necessary.
Comments from any other expert are welcome.

Comment [SMD12]: 12.06.2014: Deadline for expert comments: 31.08.2014.

Comment [SMD13]: CONFIRMATIO N: 12.09.2014.

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

~~4.2.1.3. Charge-sustaining fuel consumption and CO_2 emissions~~

~~4.2.1.3.1. Test result correction as a function of REESS charging balance~~

~~The corrected values $CO_{2,CS,corrected}$ and $FC_{CS,corrected}$ shall correspond to a zero charging balance (RCB = 0), and shall be determined according to Appendix 2 to this Annex.~~

~~4.2.1.3.2. The electricity balance, measured using the procedure specified in Appendix 3 to this Annex, shall be is used as a measure of the difference in the vehicle REESS's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance shall is to be determined for the WLTC driven.~~

~~4.2.1.3.3. The test results shall be the uncorrected measured values of $CO_{2,CS}$ and FC_{CS} in case any of the following applies:~~

~~(a) The manufacturer can prove that there is no relation between the energy balance and CO_2 emissions/fuel consumption;~~

~~(b) ΔE_{REESS} as calculated from the test result corresponds to REESS charging.~~

~~(c) ΔE_{REESS} as calculated from the test result corresponds to REESS discharging. ΔE_{REESS}, expressed as a percentage of the energy content of the fuel consumed over the cycle, shall be calculated using the equation below:~~

~~$$\Delta E_{REESS} = \frac{0.0036 \times RCB \times U_{REESS}}{E_{Fuel}} \times 100 \quad (5)$$~~

~~where:~~

~~ΔE_{REESS} is the change in the REESS energy content, per cent;~~

~~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.~~

~~ΔE_{REESS} is lower than the RCB correction criteria, according to the equation below and Table A8/5:~~

~~$\Delta E_{REESS} \leq$ RCB correction criterion~~

~~Table A8/5~~
~~**RCB correction criteria**~~

~~Cycle~~	~~WLTC (Low + Medium + High)~~	~~WLTC (Low + Medium + High + Extra High)~~
~~RCB correction criterion (%)~~	~~1~~	~~0.5~~

~~4.2.1.4. Utility factor weighted CO_2 emissions~~

~~The weighted CO_2 emissions from the charge depleting and charge sustaining test results shall be calculated using the equation below:~~

Comment [DTF14]: This content needs to be part of Appendix 2, because this is double in §4.

Comment [DTF15]: Consistency with Appendix 2!

Comment [DTF16]: Consistency with Appendix 2!

Comment [DTF17]: Covered by 4.1.3.

~~$CO_{2,weighted} = \sum_{j=1}^{k}(UF_j \times CO_{2,CD,j}) + (1 - \sum_{j=1}^{k} UF_j) \times CO_{2,CS}$ (6)~~

~~where:~~

~~$CO_{2,weighted}$ are the utility factor weighted CO_2 emissions, g/km;~~

~~UF_j is the fractional utility factor of the j^{th} phase;~~

~~$CO_{2,CD,j}$ are the CO_2 emissions measured during the j^{th} charge-depleting phase, g/km;~~

~~$CO_{2,CS}$ are the CO_2 emissions for the charge-sustaining test according to paragraph 4.2.1.3. above, g/km;~~

~~j is the index number of each phase up to the end of the transition cycle n;~~

~~k is the number of phases driven up to the end of transition cycle n.~~

4.2.3.~~1.5.~~ Utility factor weighted fuel consumption for OVC-HEV with and without driver-selectable operating modes

The utility factor weighted fuel consumption from the charge-depleting and charge-sustaining type 1 test ~~results~~ shall be calculated using the equation below:

$$FC_{weighted} = \sum_{j=1}^{k}(UF_j \times FC_{CD,j}) + (1 - \sum_{j=1}^{k} UF_j) \times FC_{CS} \quad (7)$$

where:

$FC_{weighted}$ is the utility factor weighted fuel consumption, l/100 km;

UF_j is the ~~fractional~~ utility factor ~~of the~~ of phase j^{th} ~~phase~~ according to Appendix 5 of this Annex;

$FC_{CD,j}$ is the fuel consumption ~~measured~~ determined according to paragraph 6. of Annex 7 ~~during the~~ of phase j^{th} ~~charge-depleting phase~~of the CD type 1 test, l/100 km;

FC_{CS} is the fuel consumption determined according to paragraph 4.2.1. ~~measured during the charge-sustaining test according to paragraph 4.2.1.3. above~~, l/100 km;

j is the index number of ~~each~~ the considered phase ~~up to the end of the transition cycle n~~;

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

~~4.2.2. NOVC HEV with and without driver selectable operating modes~~

~~4.2.2.1. Exhaust gases shall be analysed according to Annex 6.~~

~~4.2.2.2. Charge-sustaining fuel consumption and CO_2 emissions shall be calculated according to paragraph 4.2.1.3. of this Annex.~~

~~4.2.2.3. Test result correction as a function of REESS charging balance~~

Comment [DTF18]: U.U. Anpassung nach Appendix 2 nötig!

Comment [DTF19]: Covered by 4.2.1 and Appendix 2.

Comment [DTF20]: Double to 4.1.

~~The corrected values $CO_{2,CS,corrected}$ and $FC_{CS,corrected}$ shall correspond to a zero energy balance (RCB = 0), and shall be determined according to Appendix 2 to this Annex.~~

~~4.2.2.3.1. The electricity balance, measured using the procedure specified in Appendix 3 to this Annex, shall beis used as a measure of the difference in the vehicle REESS'REESS's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance shall is to be determined for the WLTC driven.~~

~~4.2.2.3.2. The test results shall be the uncorrected measured values of $CO_{2,CS}$ and FC_{CS} in case any of the following applies:~~

~~(a) The manufacturer can prove that there is no relation between the energy balance and fuel consumption;~~

~~(b) ΔE_{REESS} as calculated from the test result corresponds to REESS charging;~~

~~(c) ΔE_{REESS} as calculated from the test result corresponds to REESS discharging. ΔE_{REESS}, expressed as a percentage of the energy content of the fuel consumed over the cycle, shall be is calculated usingin the equation below:~~

~~$$\Delta E_{REESS} = \frac{0.0036 \times \sum_{i=1}^{z} (RCB_i \times U_{REESSi})}{E_{fuel}} \times 100 \quad (8)$$~~

~~where:~~

~~U_{REESSi} is the nominal REESS voltage for i^{th} REESS, V;~~

~~RCB_i is the charging balance over the whole cycle for the i^{th} REESS, Ah;~~

~~E_{fuel} is the energy content of the consumed fuel, MJ.~~

~~i index of REESS;~~

~~z number of installed REESS.~~

~~ΔE_{REESS} is smaller than the RCB correction criteriacriteria, according to the following equation and Table A8/6 :~~

~~$\Delta E_{REESS} \leq$ RCB correction criteriacriterion~~

~~Table A8/6~~
~~**RCB correction criteria**~~

~~*Cycle*~~	~~*WLTC (Low + Medium + High)*~~	~~*WLTC (Low + Medium + High + Extra High)*~~
~~RCB correction criteria criterion (%)~~	~~1~~	~~0.5~~

~~4.2.2.3.3. Where RCB corrections of CO_2 and fuel consumption measurement values are required, the procedure described in Appendix 2 to this Annex shall be used.~~

4.3. Calculation of electric energy consumption

For the determination of the electric energy consumption based on the measured current as described in Appendix 3 of this Annex the following

equations shall be used (Please note that a common subscription is used here.):

$$EC_{DC,j} = \frac{\Delta E_{REESS,j}}{d_j} \quad (6)$$

where:

$EC_{DC,j}$ is the electric energy consumption of the considered period j based on the REESS depletion, Wh/km;

$\Delta E_{REESS,j}$ is the sum of electric energy changes of all REESS of the considered period j, Wh;

d_j is the distance driven in the considered period j, km;

and

$$\Delta E_{REESS,j} = \sum_{i=1}^{n} \Delta E_{REESS,j,i} \quad (7)$$

where:

$\Delta E_{REESS,j}$ is the sum of electric energy changes of all REESS of the considered period j, Wh;

$\Delta E_{REESS,j,i}$ is the change of electric energy of REESS i of the considered period j, Wh;

and

$$\Delta E_{REESS,j,i} = \frac{1}{3600} \times U_{REESS,i} \times \int_{t_0}^{t_{end}} I(t)_{j,i}\, dt \quad (8)$$

where:

$\Delta E_{REESS,j,i}$ is the change of electric energy of REESS i of the considered period j, Wh;

$U_{REESS,i}$ is the nominal voltage of REESS i determined according to DIN EN 60050-482, V;

t_0 is the time at the beginning of the considered period j, s;

t_{end} is the time at the end of the considered period j, s;

$I(t)_{j,i}$ is the electric current of REESS i of the considered period j (REESS-depletion is said to be a positive current), A;

i is the index for the amount of REESS;

n is the total amount of REESS;

j is the index for the considered period.

4.3.1. ~~OVC-HEV~~Utility factor weighted charge-depleting electric energy consumption based on the recharged energy from the mains for OVC-HEV with and without driver-selectable operating modes

The utility factor weighted charge-depleting electric energy consumption based on the recharged energy from mains shall be calculated as follows:

$$EC_{AC,CD} = \frac{\sum_{j=1}^{k}(UF_j \times EC_{AC,CD,j})}{\sum_{j=1}^{k} UF_j} \quad (9)$$

$$EC_{AC,CD,j} = EC_{DC,CD,j} \times \frac{E_{AC}}{\sum_{j=1}^{k} \Delta E_{REESS,j}} \quad (10)$$

where:

$EC_{AC,CD}$ is the utility factor weighted charge-depleting electric energy consumption based on the recharged energy from the mains, Wh/km;

$EC_{AC,CD,j}$ is the electric energy consumption based on the recharged energy from the mains of phase j according to equation 10 of this Annex, Wh/km;

UF_j is the utility factor of phase j according to Appendix 5 of this Annex;

$EC_{DC,CD,j}$ is the electric energy consumption based on the REESS depletion of phase j of the CD type 1 test according to paragraph 4.3. of this Annex, Wh/km;

E_{AC} is the recharged electric energy from the mains determined according to paragraph 3.2.4.6.of this Annex, Wh;

$\Delta E_{REESS,j}$ is the sum of electric energy changes of all REESS of phase j, Wh according to paragraph 4.3. of this Annex;

j is the index number of the considered phase;

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

4.3.2.~~1.1.~~ Utility factor weighted ~~total AC~~ electric energy consumption based on the recharged energy from the main for OVC-HEV with and without driver-selectable operating modes~~including charging losses shall be calculated using the following equations:~~

The utility factor weighted electric energy consumption based on the recharged energy from the mains shall be calculated as follows:

$$EC_{AC,weighted} = \sum_{j=1}^{k} (UF_j \times EC_{AC,CD,j}) \quad (9\text{11})$$

~~$$EC_{CD,j} = \frac{RCB_j}{d_j * \sum_{j=1}^{k} RCB_j} \times E_{AC} \quad (10)$$~~

where:

$EC_{AC,weighted}$ is the utility factor weighted ~~total~~ electric energy consumption based on the recharged energy from the mains, Wh/km;

UF_j is the ~~driving cycle and phase specific~~ utility factor of phase j according to Appendix 5 of this Annex;

$EC_{AC,CD,j}$ is the electric energy consumption based on the recharged energy from the mains of phase j according to equation 10 of this Annex, Wh/km;~~is the calculated fraction of E_{AC} used in the j^{th} phase during the charge-depleting test, Wh/km;~~

~~RCB_j is the measured charge balance of the traction REESS of the j^{th} phase during the charge-depleting test, Ah;~~~~d_j is the~~

Comment [DTF21]: Already covered in 4.3.1.

~~distance driven in the j[th] phase during the charge-depleting test, km;~~

~~E_{AC} is the measured recharged electric energy from the mains, Wh;~~

j is the index number of ~~each~~ the considered phase; ~~up to the end of transition cycle n;~~

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

~~4.3.1.2. Electric energy consumption including charging losses~~

~~4.3.1.2.1. Recharged electric energy E in Wh and charging time measurements shall be recorded.~~

4.3.3.~~1.2.2.~~ Electric energy consumption for OVC-HEV with and without driver-selectable operating modes~~EC is defined by the equation:~~

The electric energy consumption based on the recharged electric energy from the mains and the equivalent all electric range shall be calculated as follows:

$$EC = \frac{E_{AC}}{EAER}$$ ~~$E_{AC}/EAER$~~ (~~11~~12)

where:

EC is the electric energy consumption based on the recharged electric energy from the mains and the equivalent all electric range, Wh/km;

E_{AC} is the recharged electric energy from the mains according to paragraph 3.2.4.6. of this Annex, Wh;

EAER is the equivalent all electric range according to paragraph 4.4.3.2. of this Annex~~below~~, km.

~~4.3.1.3. Charge-depleting AC electric energy consumption, EC_{CD}, including charging losses~~

~~$$EC_{CD} = \frac{EC_{weighted}}{\sum_{j=1}^{k} UF_j} \quad (12)$$~~

~~where:~~

~~$EC_{weighted}$ is the electric energy consumption, Wh/km;~~

~~EC_{CD} is the recharged electric energy from the grid including charging losses, Wh;~~

~~UF_j is the driving cycle and phase specific utility factor according to Appendix 5 to this Annex;~~

~~j is the index number of each phase up to the end of transition cycle n;~~

~~k is the number of phases driven up to the end of transition cycle n.~~

~~4.3.2. Pure electric vehicle (PEV)~~

~~4.3.2.1. Recharged electric energy E in Wh and charging time measurements shall be recorded.~~

Comment [DTF22]: Equation that included these symbols was shifted to 4.3.1.

Comment [DTF23]: Addressed to 4.3.3.

Comment [DTF24]: This shall be shifted to §3 or Appendix 3 because this is no calculation but a requirement to the procedure

Comment [DTF25]: Consistency of equations!

Comment [DTF26]: Shifted to 4.3.1

Comment [DTF27]: Addressed to 4.3.4

Comment [DTF28]: Already covered in 3.4.3.5

4.3.4.2.2. ~~The e~~Electric energy consumption for PEV with and without driver-selectable operating modes~~EC including charging losses is defined by the equation:~~

The electric energy consumption based on the recharged electric energy from the mains and the all electric range shall be calculated as follows:

$$EC = \frac{E_{AC}}{AER} \quad (13)$$ ~~E_{AC}/AER~~

where:

EC is the electric energy consumption based on the recharged electric energy from the mains and the all electric range, Wh/km;

E_{AC} is the recharged electric energy from the mains according to paragraph 3.4.3.5. of this Annex , Wh;

AER is the all-electric range as defined in paragraph 4.4.1. of this Annex, km;

4.4. Calculation of ~~E~~electric ~~R~~ranges

4.4.1. All electric range for OVC-HEV and PEV with and without driver-selectable operating modes

The all electric range AER for OVC-HEV shall be determined from the CD type 1 test that is described in paragraph 3.2.4.3. of this Annex as part of the Option 1 test sequence and is referenced in paragraph 3.2.6.1. of this Annex as part of the Option 3 test sequence. The AER is defined to be the distance driven from the beginning of the CD type 1 test up to the point of time the combustion engine starts consuming fuel.

The all electric range AER for PEV shall be determined from the type 1 test as described in paragraph 3.4.3. of this Annex. The AER is defined to be ~~T~~the distance driven ~~over consecutive WLTCs~~from the beginning of the type 1 test ~~until~~up to the point of time the break-off criterion according to paragraph 3.4.3.4. ~~3.4.4.3.1.3. above~~ is reached. ~~shall be measured and be rounded to the nearest whole number according to paragraph 3.4.2.4.1.3. above.~~

4.4.2. Charge-depleting cycle range for OVC-HEV with and without driver-selectable operating modes

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

~~4.4.1.1. All electric range, AER, and all electric range city, AERcity~~

~~The distance driven over consecutive test cycles according to paragraph 1.5.1.1. using only the REESS until the combustion engine starts consuming fuel for the first time shall be measured and be rounded to the nearest whole number.~~

Comment [DTF29]: Covered by 4.4.1.

4.4.3.~~1.2.~~ Equivalent all electric range~~, EAER~~ for OVC-HEV with and without driver-selectable operating modes

The equivalent all electric range shall be calculated as follows:

~~4.4.1.2.1. EAER shall be calculated as follows:~~

$$EAER = \left(\frac{\text{~~CO~~}M_{CO2,CS} - \text{~~CO~~}M_{CO2,CD,avg}}{\text{~~CO~~}M_{CO2,CS}}\right) \times R_{CDC} \qquad (14)$$

where:

EAER is the equivalent all electric range ~~EAER~~, km;

$M_{CO2,CS}$ is the charge-sustaining CO_2 mass emission according to paragraph 4.1.1. of this Annex, g/km;

$M_{CO2,CD,avg}$ is the average charge-depleting CO_2 mass emission according to equation 15, g/km;

R_{CDC} is the charge-depleting cycle range according to paragraph 4.4.2. of this Annex, km;

and

$$\text{~~CO~~}M_{CO2,CD,avg} = \frac{\sum_{j=1}^{k} \text{~~CO~~}(M_{CO2,CD,j} \times d_j)}{\sum_{j=1}^{k} d_j} \qquad (15)$$

where:

~~$CO_{2,CS}$ are the CO_2 emissions during the charge-sustaining test, g/km;~~

$M_{CO2,CD,avg}$ is the average charge-depleting CO_2 mass emission, g/km;

$M_{CO2,CD,j}$ is the CO_2 mass emission~~s~~ determined according to paragraph 3.2.1. of Annex 7 of phase j of the CD type 1 test, g/km;

d_j is the distance driven in ~~the jth~~ phase j of the CD type 1 test~~during the charge-depleting test~~, km;

~~R_{CDC} is the charge-depleting cycle range, km;~~

j is the index number of ~~each~~ the considered phase~~; up to the end of the transition cycle n;~~

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

~~4.4.1.3. Charge-depleting cycle range (R_{CDC})~~

~~The distance from the beginning of the charge-depleting test to the end of the last cycle prior to the cycle or cycles satisfying the break-off criteria criterion shall be measured. This shall include the distance travelled during the transition cycle where the vehicle operates in both depleting and sustaining modes. If the charge-depleting test possesses a transition range, the R_{cdc} shall include those transition cycles or cycles.~~

4.4.4.~~1.4.~~ Actual charge-depleting ~~cycle~~ range for OVC-HEV with and without driver-selectable operating modes ~~(R_{CDA})~~

Comment [DTF30]: Now covered in 4.4.2

Comment [DTF31]: Wait for Matthias response, what is the new paragraph?

Comment [DTF32]: There was no $CO_{2,CD,ave}$ with the Unit g available in the GTR. Therefore amendments to the formula had been necessary.

Comment [DTF33]: Shifted and corrected to equation 14.

Comment [DTF34]: Shifted to the equation above (14).

Comment [DTF35]: Double to 3.2.9.4. Due to the fact that there is no calculation this should be part of §3.

Comment [DTF36]: Consistency to symbol explanation below.

The actual charge depleting range shall be calculated as follows:

$$R_{CDA} = \sum_{cj=1}^{n-1} d_c + \left(\frac{M_{CO2,CS} - M_{CO2,n,cycle}}{M_{CO2,CS} - M_{CO2,CD,avg,n-1}}\right) \times d_n \qquad (16)$$

where:

R_{CDA} is the actual charge-depleting range, km;

$M_{CO2,CS}$ is the charge-sustaining CO_2 mass emissions according to paragraph 4.1.1. of this Annex, g/km;

$M_{CO2,n,cycle}$ is the CO_2 mass emissions ~~over the n^th^ of drive~~ test cycle n of the CD type 1 test~~in charge-depleting operating condition~~, g/km;

$M_{CO2,CD,avg,n-1}$ is the average CO_2 mass emission of the CD type 1 test from the beginning to test cycle (n-1)~~s in charge-depleting operating condition until the n-1^th^ drive cycle~~, g/km;

$d_{cj,cycle}$ is the ~~test~~ distance ~~travelled~~ driven ~~during j^th^ in drive~~ test cycle c of the CD type 1 test, km;

d_n is the ~~test~~ distance ~~travelled~~ driven ~~during the n^th^ drive cycle in charge depleting operating condition~~in test cycle n of the CD type 1 test, km;

~~j~~c is the index number of ~~each~~ the considered ~~whole~~ test cycle ~~up to the end of the transition cycle n~~;

n is the number of ~~whole~~ driven test cycles ~~driven~~ including the transition cycle according to paragraph 3.2.4.4. of this Annex; ~~n.~~

and

$$M_{CO2,CD,avg,n-1} = \frac{\sum_{c=1}^{n-1}(M_{CO2,CD,c} \times d_c)}{\sum_{c=1}^{n-1} d_c} \qquad (17)$$

where:

$M_{CO2,CD,avg,n-1}$ is the average CO_2 mass emission of the CD type 1 test from the beginning to test cycle (n-1), g/km;

$M_{CO2,CD,c}$ is the CO_2 mass emission determined according to paragraph 3.2.1. of Annex 7 of test cycle c of the CD type 1 test, g/km;

c is the index number of the considered test cycle;

n is the number of driven test cycles including the transition cycle according to paragraph 3.2.4.4 of this Annex;

~~4.4.2. PEV~~

~~4.4.2.1. All electric range, AER~~

~~The distance driven over consecutive WLTCs until the break-off criterion according to paragraph 3.4.4.3.1.3. above is reached shall be measured and be~~

Comment [DTF37]: Shifted to 4.4.1

~~rounded to the nearest whole number according to paragraph 3.4.2.4.1.3. above.~~

~~4.4.2.2. All-electric city range, AERcity~~

~~The distance driven over consecutive WLTC city cycles until the break-off criteria criterion according to paragraph 3.4.4.3.1.3. above is reached shall be measured and be rounded to the nearest whole number.~~

[RESERVED : Combined approach]

Annex 8 - Appendix 1~~a~~

1. Test sequences and REESS profiles: OVC-HEV, charge-depleting and charge-sustaining test

1.1. Test sequence OVC-HEV according to option 1: Charge-depleting type 1 test with no subsequent charge-sustaining type 1 test (A8.App1a/1)

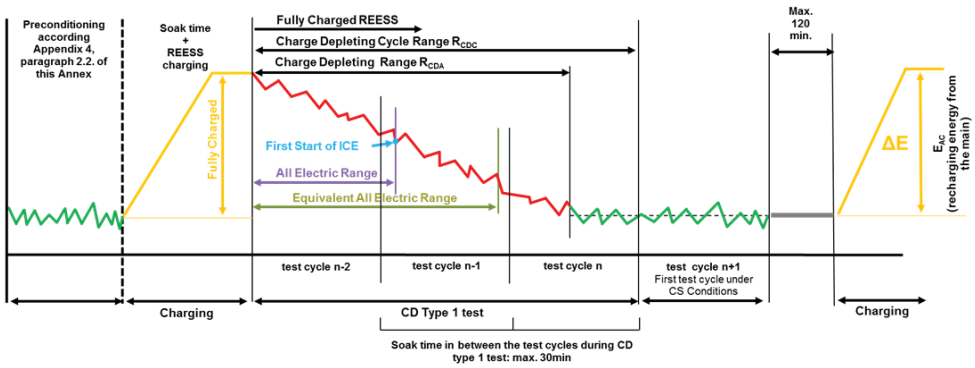


Figure A8.App1a/1
OVC-HEV, charge-depleting type 1 test

1.2. Test sequence OVC-HEV according to option 2:
Charge-sustaining type 1 test with no subsequent charge-depleting type 1 test (A8.App1a/2)

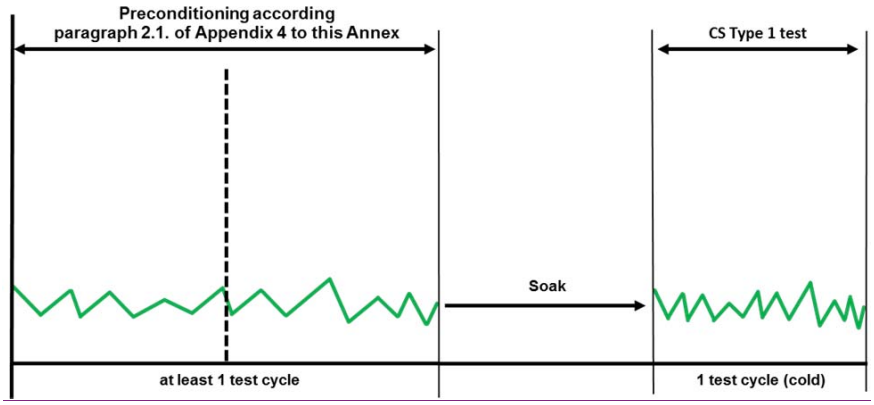


Figure A8.App1a/2
OVC-HEV, charge-sustaining type 1 test

1.3. Test sequence OVC-HEV according to option 3:

Charge-depleting type 1 test with subsequent charge-sustaining type 1 test (A8.App1a/3)

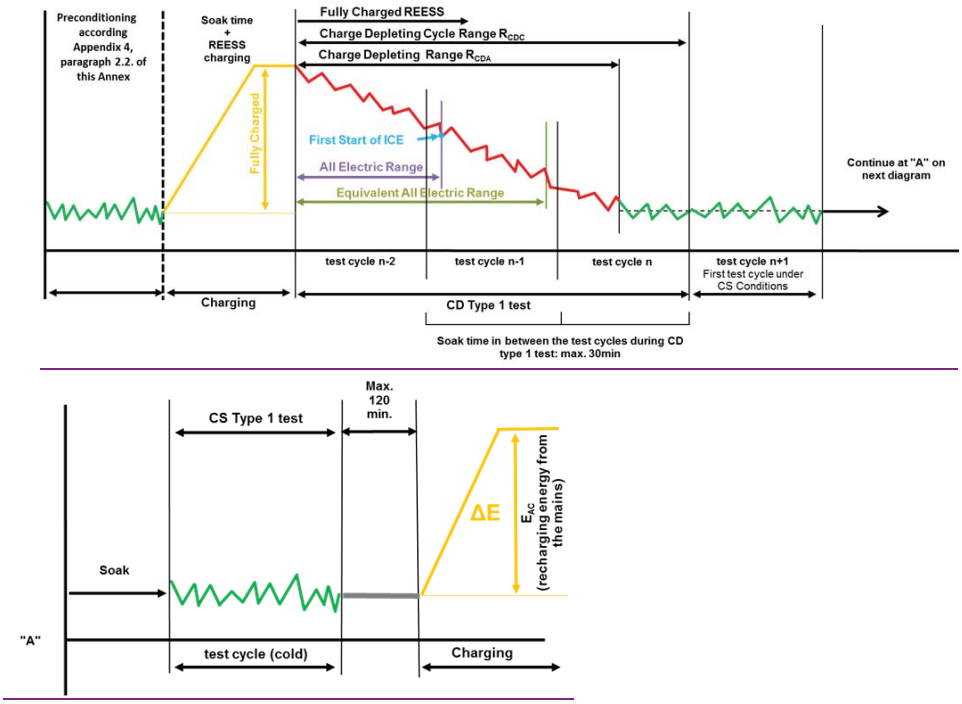


Figure A8.App1a/3

OVC-HEV, Charge-depleting type 1 test with subsequent charge-sustaining type 1 test

1.4. Test sequence OVC-HEV according to option 4:

Charge-sustaining type 1 test with subsequent charge-depleting type 1 test (A8.App1a/4)

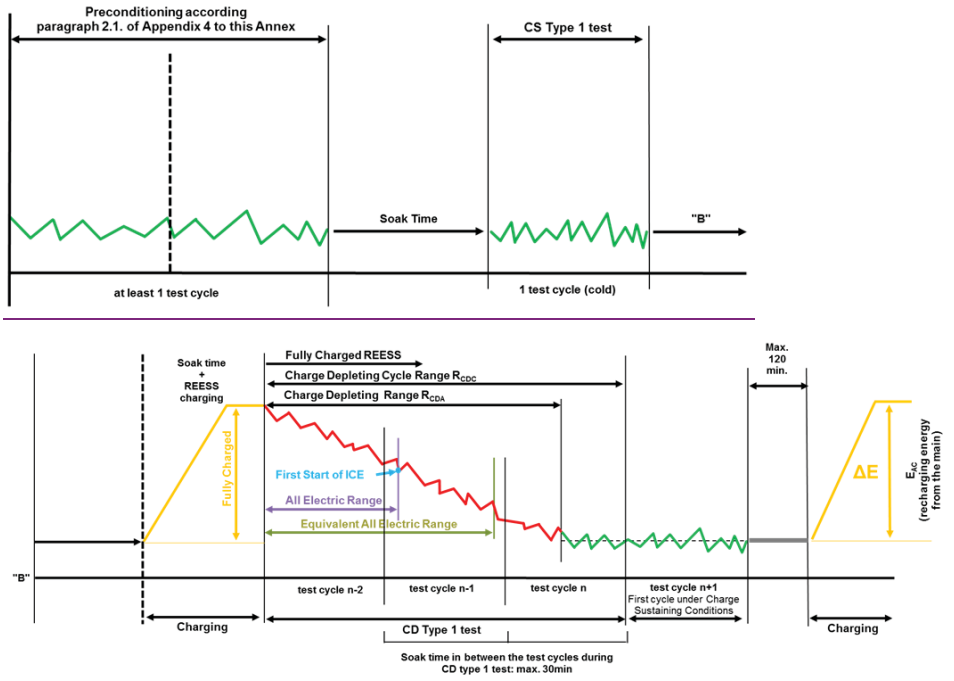


Figure A8.App1a/4
OVC-HEV, Charge-sustaining type 1 test with subsequent charge-depleting type 1 test

~~1. RCB profile OVC-HEV, charge-depleting test (Figure A8.App1a/1) followed by a charge-sustaining test (Figure A8.App1a/2)~~

~~Figure A8.App1a/1~~
~~**OVC-HEV, charge-depleting test**~~

~~2. RCB profile OVC HEV, charge sustaining test (Figure A8.App1a/2) preceded by a charge-depleting test (Figure A8.App1a/1)~~

~~Figure A8.App1a/2~~
~~**OVC HEV, charge sustaining test**~~

2. Test sequence NOVC-HEV, charge-sustaining type 1 test

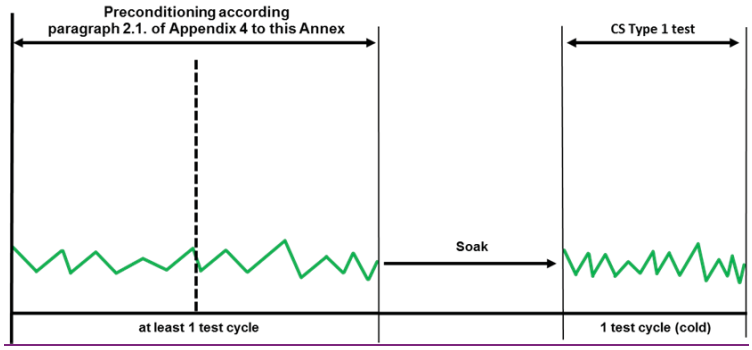


Figure A8.App1a/5
NOVC-HEV, Charge-sustaining type 1 test

3. Test sequence PEV

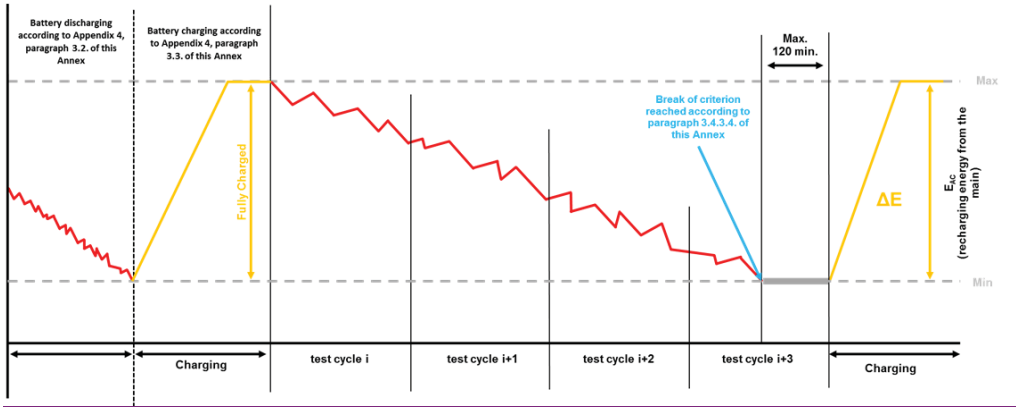


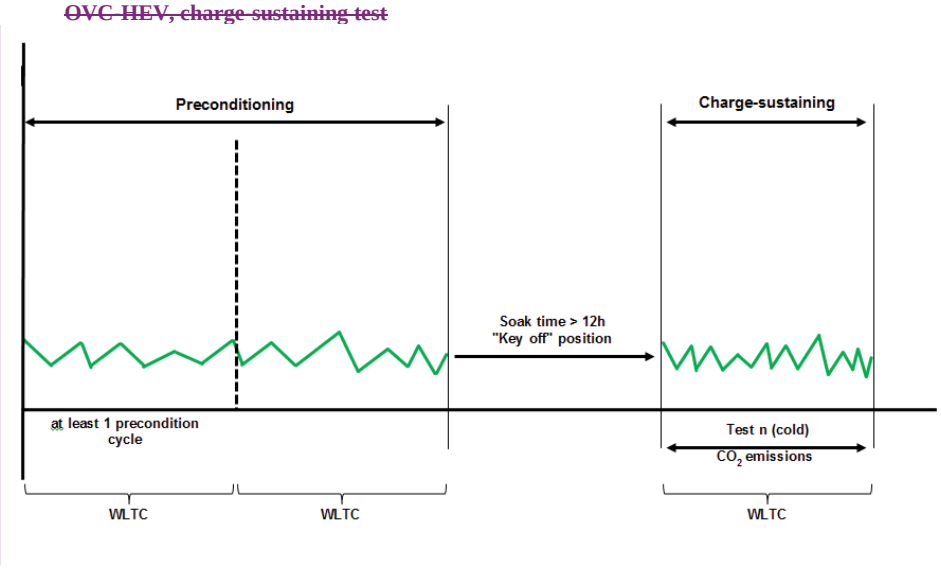
Figure A8.App1a/6
Test sequence PEV

~~Annex 8 -Appendix 1b~~

~~RCB profile, OVC-HEV and NOVC-HEV charge-sustaining test~~

~~1. RCB profile OVC-HEV, charge-sustaining test (Figure A8.App1b/1)~~

~~Figure A8.App1b/1~~
~~**OVC-HEV, charge-sustaining test**~~



Comment [DTF77]:
Check Soak Time > 12h?!?!?

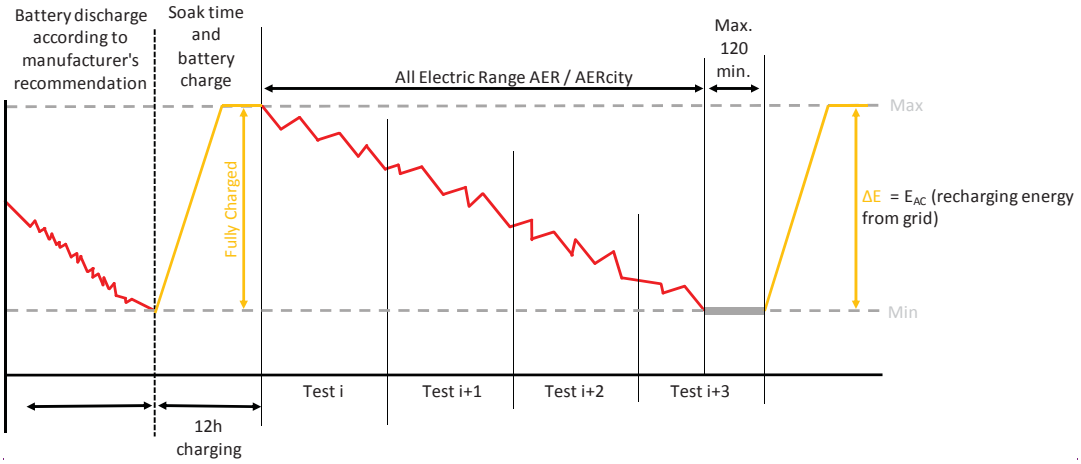
Soaking according Annex 6 §1.2.7
Min 6h max 36h

~~Annex 8 -Appendix 1c~~

~~RCB profile, PEV, electric range and electric energy consumption test~~

~~1. RCB profile, PEV, electric range and electric energy consumption test (Figure A8.App1c/1)~~

~~Figure A8.App1c/1~~
~~**PEV, electric range and electric energy consumption test**~~



Annex 8 -Appendix 2

REESS charge balance (RCB) correction

This Appendix describes the test procedure for REESS charge balance compensation of CO_2 and fuel consumption for NOVC-HEV and OVC-HEV for the CS type 1 test.

1. General requirements

1.1. For the determination if a correction is required according to paragraph 1.2. of this Appendix equation 7 and equation 8 shall be used to calculate the charge-sustaining REESS energy change $\Delta E_{REESS,CS}$ of the CS type 1 test. The considered period is defined by the CS type 1 test.

1.2. The correction of the charge-sustaining fuel consumption and the charge-sustaining CO_2 mass emission shall be omitted and the uncorrected values shall be used if any of the following criteria is fulfilled:

(a) The manufacturer can prove the technical service by measurement that there is no relation between $\Delta E_{REESS,CS}$ and CO_2 mass emission and $\Delta E_{REESS,CS}$ and fuel consumption respectively;

(b) $\Delta E_{REESS,CS}$ corresponds to REESS charging (according to paragraph 4.3. of this Annex REESS charging leads to a negative REESS energy change);

(c) $\Delta E_{REESS,CS}$ corresponds to REESS discharging (according to paragraph 4.3. of this Annex REESS discharging leads to a positive REESS energy change) and the correction criterion according to paragraph 1.3. of this Appendix is not fulfilled.

1.3. The correction criterion is fulfilled, if the charge-sustaining REESS energy change $\Delta E_{REESS,CS}$ is bigger than the cycle specific percentage according to Table A8/5 of fuel energy based on the charge-sustaining fuel consumption. The criterion shall be validated as follows:

$$\frac{\Delta E_{REESS,CS}}{E_{fuel,CS}} \times 100 > correction\ criterion \quad (1)$$

where:

$\Delta E_{REESS,CS}$ is the charge-sustaining REESS energy change according to paragraph 1.1. of this Appendix, Wh;

$E_{fuel,CS}$ is the charge-sustaining fuel energy according to equation 2 of this Paragraph, Wh;

and

$$E_{fuel,CS} = \frac{1}{360} \times NHV \times \rho_{fuel} \times FC_{CS,nb} \times d_{CS} \quad (2)$$

where:

$E_{fuel,CS}$ is the charge-sustaining fuel energy, Wh;

NHV is the net heating value according to the certificate of the reference fuel, MJ/kg;

Comment [DTF38]: Covers and summarizes the paragraphs 4.2.1.3.1. et seqq. and 4.2.2.3. et seqq.

ρ_{fuel} is the density according to the certificate of the reference fuel, kg/m³;

$FC_{CS,nb}$ is the non-balanced charge-sustaining fuel consumption of the CS type 1 test determined according to paragraph 6. of Annex 7, l/100 km;

d_{CS} is the distance driven over the corresponding CS type 1 test cycle, km;

$\frac{1}{360}$ conversion factor to Wh.

Table A8/5
Correction criteria

Test cycle	*Low + Medium + High*	*Low + Medium + High + Extra High*
Correction criterion (%)	1	0.5

1.4. If any of the criteria according to paragraph 1.2 of this Appendix is fulfilled the following charge-sustaining CO2 mass emission and charge-sustaining fuel consumption shall be used:

$$M_{CO2,CS} = M_{CO2,CS,nb} \quad (3)$$

where:

$M_{CO2,CS}$ is the charge-sustaining CO_2 mass emission of the CS type 1 test, g/km;

$M_{CO2,CS,nb}$ is the non-balanced charge-sustaining CO_2 mass emission of the CS type 1 test determined according to paragraph 3.2.1. of Annex 7, g/km;

and

$$FC_{CS} = FC_{CS,nb} \quad (4)$$

where:

FC_{CS} is the charge-sustaining fuel consumption of the CS type 1 test, l/100 km;

$FC_{CS,nb}$ is the non-balanced charge-sustaining fuel consumption of the CS type 1 test determined according to paragraph 6. of Annex 7, l/100 km.

Otherwise the values shall be corrected as follows in paragraph 2 et seqq. of this Appendix.

2. Correction methodology

2.1. CO_2 mass emission and fuel consumption correction coefficient K_{CO2}/K_{fuel} respectively coefficients $K_{CO2,m}/K_{fuel,m}$ shall be calculated based on CS type 1 test cycles.

2.2. The correction coefficients shall be determined from a set of n_{CS} CS type 1 tests performed by the manufacturer. This set shall contain at least one test with $\Delta E_{REESS,CS} \leq 0$ and at least one with $\Delta E_{REESS,CS} > 0$. $\Delta E_{REESS,CS,n}$ is the

Comment [DTF39]: The whole paragraph 2 includes the content of Appendix 2 from GTR 1a. Compared to GTR 1a several issues had been reworked. Many of the issues had been necessary because the methodology more or less had been a copy from ECE R83/101. But the methodology is not directly applicable to the WLTC, e.g. due to the fact that the WLTC consists of 3 or 4 phases instead of 2. Furthermore the description of the methodology was improved.

Additionally the new structure of the Appendix is a better basis for the next adoption of the "cycle specific family correction factor".

sum of electric energy changes of all REESS of test n calculated according to paragraph 1.1 of this Annex.

If the latter condition cannot be realised on the test cycle, the responsible authority shall evaluate the statistical significance of the extrapolation that is necessary to determine the corrected CO_2 mass emission and fuel consumption at $\Delta E_{REESS,CS} = 0$.

2.3. Determination of fuel consumption correction coefficient

2.3.1. The fuel consumption correction coefficient (K_{fuel}) determined by driving a set of CS type 1 tests, is defined as follows:

$$K_{fuel} = \frac{\sum_{n=1}^{n_{CS}}\left((EC_{DC,CS,n} - EC_{DC,CS,avg}) \times (FC_{CS,nb,n} - FC_{CS,nb,avg})\right)}{\sum_{n=1}^{n_{CS}}(EC_{DC,CS,n} - \overline{EC_{DC,CS}})^2} \quad (5)$$

where:

K_{fuel} is the fuel consumption correction coefficient, l/100 km/Wh/km;

$EC_{DC,CS,n}$ is the charge-sustaining electric energy consumption of CS type 1 test n based on the REESS depletion according to equation 8 of this Appendix, Wh/km;

$EC_{DC,CS,avg}$ is the average charge-sustaining electric energy consumption of n_{CS} CS type 1 tests based on the REESS depletion according to equation 6 of this Appendix, Wh/km;

$FC_{CS,nb,n}$ is the non-balanced charge-sustaining fuel consumption of the CS type 1 test n calculated according to paragraph 6 of Annex 7, l/100 km;

$FC_{CS,nb,avg}$ is the average charge-sustaining fuel consumption of n_{CS} CS type 1 tests based on the non-balanced fuel consumption according to equation 7 of this Appendix, l/100 km;

n is the index number of the considered test;

n_{CS} is the total amount of CS type 1 tests;

and

$$EC_{DC,CS,avg} = \frac{1}{n_{CS}} \times \sum_{n=1}^{n_{CS}} EC_{DC,CS,n} \quad (6)$$

where:

$EC_{DC,CS,avg}$ is the average charge-sustaining electric energy consumption of n_{CS} CS type 1 tests based on the REESS depletion , Wh/km;

$EC_{DC,CS,n}$ is the charge-sustaining electric energy consumption of CS type 1 test n based on the REESS depletion according to equation 8 of this Appendix, Wh/km;

and

$$FC_{CS,nb,avg} = \frac{1}{n_{CS}} \times \sum_{n=1}^{n_{CS}} FC_{CS,nb,n} \quad (7)$$

where:

$FC_{CS,nb,avg}$ is the average charge-sustaining fuel consumption of n_{CS} CS type 1 tests based on the non-balanced fuel consumption, l/100 km;

$FC_{CS,nb,n}$ is the non-balanced charge-sustaining fuel consumption of the CS type 1 test n calculated according to paragraph 6 of Annex 7, l/100 km;

and

$$EC_{DC,CS,n} = \frac{\Delta E_{REESS,CS,n}}{d_{CS,n}} \quad (8)$$

where:

$EC_{DC,CS,n}$ is the charge-sustaining electric energy consumption measured of test n, Wh/km;

$\Delta E_{REESS,CS,n}$ is the charge-sustaining REESS energy change of test n according to paragraph 1.1. of this Appendix, Wh;

$d_{CS,n}$ is the distance driven over the corresponding CS type 1 test n, km.

The fuel consumption correction coefficient shall be rounded to four significant figures. The statistical significance of the fuel consumption correction coefficient shall be evaluated by the responsible authority.

2.3.2. The fuel consumption correction coefficient can be applied for the correction of each individual phase.

2.3.3. Without prejudice to the requirements of paragraph 2.2. of this Appendix, at the manufacturer's request, separate fuel consumption correction coefficients $K_{fuel,m}$ for each individual phase may be developed. Therefore the same conditions as described in paragraph 2.2. of this Appendix have to be fulfilled in each individual phase and the procedure described in paragraph 2.3.1. of this Appendix shall be applied for each individual phase to determine each phase correction coefficients.

2.4. Determination of the corrected fuel consumption

2.4.1. The charge-sustaining fuel consumption shall be determined as follows:

$$FC_{CS} = FC_{CS,nb,avg} - K_{fuel} \times EC_{DC,CS,avg} \quad (9)$$

where:

FC_{CS} is the charge-sustaining fuel consumption of the CS type 1 test, l/100 km;

$FC_{CS,nb,avg}$ is the average charge-sustaining fuel consumption of n_{CS} CS type 1 tests based on the non-balanced fuel consumption according to equation 7 of this Appendix, l/100 km;

$EC_{DC,CS,avg}$ is the average charge-sustaining electric energy consumption of n_{CS} CS type 1 tests based on the REESS depletion according to equation 6 of this Annex , Wh/km;

K_{fuel} is the fuel consumption correction coefficient according to equation 5 of this Annex, l/100 km/Wh/km.

2.4.2. In case of missing fuel consumption correction coefficients for each phase m, the each phase fuel consumption shall be calculated as follows:

$$FC_{CS,m} = FC_{CS,nb,avg,m} - K_{fuel} \times EC_{DC,CS,avg,m} \quad (10)$$

where:

$FC_{CS,m}$ is the charge-sustaining fuel consumption of phase m of the CS type 1 test, l/100 km;

$FC_{CS,nb,avg,m}$ is the average charge-sustaining fuel consumption of phase m of n_{CS} CS type 1 tests based on the non-balanced fuel consumption of phase m, l/100 km;

$EC_{DC,CS,avg,m}$ is the average charge-sustaining electric energy consumption of phase m of n_{CS} CS type 1 tests based on the REESS depletion, Wh/km;

K_{fuel} is the fuel consumption correction coefficient according to equation 5 of this Annex, l/100 km/Wh/km.

2.4.3. In case of available fuel consumption correction coefficients for each phase m, the each phase fuel consumption shall be calculated as follows:

$$FC_{CS,m} = FC_{CS,nb,avg,m} - K_{fuel,m} \times EC_{DC,CS,avg,m} \quad (11)$$

where:

$FC_{CS,m}$ is the charge-sustaining fuel consumption of phase m of the CS type 1 test, l/100 km;

$FC_{CS,nb,avg,m}$ is the average charge-sustaining fuel consumption of phase m of n_{CS} CS type 1 tests based on the non-balanced fuel consumption of phase m, l/100 km;

$EC_{DC,CS,avg,m}$ is the average charge-sustaining electric energy consumption of phase m of n_{CS} CS type 1 tests based on the REESS depletion, Wh/km;

$K_{fuel,m}$ is the fuel consumption correction coefficient for the correction of phase m determined according to paragraph 2.3.3. of this Appendix, l/100 km/Wh/km;

m is the index for the phases of the considered test cycle.

2.5. Determination of CO_2 mass emission correction coefficient

2.5.1. The CO_2 mass emission correction coefficient (K_{CO2}) determined by driving a set of CS type 1 tests, is defined as follows:

$$K_{CO2} = \frac{\sum_{n=1}^{n_{CS}}\left(\left(EC_{DC,CS,n} - EC_{DC,CS,avg}\right) \times \left(M_{CO2,CS,nb,n} - M_{CO2,CS,nb,avg}\right)\right)}{\sum_{n=1}^{n_{CS}}\left(EC_{DC,CS,n} - \overline{EC_{DC,CS}}\right)^2} \quad (12)$$

where:

K_{CO2} is the CO_2 mass emission correction coefficient, g/km/Wh/km;

$EC_{DC,CS,n}$ is the charge-sustaining electric energy consumption of CS type 1 test n based on the REESS depletion according to equation 8 of this Appendix, Wh/km;

$EC_{DC,CS,avg}$ is the average charge-sustaining electric energy consumption of n_{CS} CS type 1 tests based on the REESS depletion according to equation 6 of this Appendix, Wh/km;

$M_{CO2,CS,nb,n}$ is the non-balanced charge-sustaining CO_2 mass emission of the CS type 1 test n calculated according to paragraph 3.2.1. of Annex 7, g/km;

$M_{CO2,CS,nb,avg}$ is the average charge-sustaining CO_2 mass emission of n_{CS} CS type 1 tests based on the non-balanced CO_2 mass emission according to equation 13 of this Appendix, g/km;

n is the index number of the considered test;

n_{CS} is the total amount of CS type 1 tests;

and

$$M_{CO2,CS,nb,avg} = \frac{1}{n_{CS}} \times \sum_{n=1}^{n_{CS}} M_{CO2,CS,nb,n} \quad (13)$$

where:

$M_{CO2,CS,nb,avg}$ is the average charge-sustaining CO_2 mass emission of n_{CS} CS type 1 tests based on the non-balanced CO_2 mass emission, g/km;

$M_{CO2,CS,nb,n}$ is the non-balanced charge-sustaining CO_2 mass emission of the CS type 1 test n calculated according to paragraph 3.2.1. of Annex 7, g/km.

The CO_2 mass emission correction coefficient shall be rounded to four significant figures. The statistical significance of the CO_2 mass emission correction coefficient shall be evaluated by the responsible authority.

2.5.2. The CO_2 mass emission correction coefficient can be applied for the correction of each individual phase.

2.5.3. Without prejudice to the requirements of paragraph 2.2. of this Appendix, at the manufacturer's request, separate CO_2 mass emission correction coefficients $K_{CO2,m}$ for each individual phase may be developed. Therefore the same conditions as described in paragraph 2.2. of this Appendix have to be fulfilled in each individual phase and the procedure described in

paragraph 2.5.1. of this Appendix shall be applied for each individual phase to determine each phase correction coefficients.

2.6. Determination of the CO_2 mass emission

2.6.1. The charge-sustaining CO_2 mass emission shall be determined as follows:

$$M_{CO2,CS} = M_{CO2,CS,nb,avg} - K_{CO2} \times EC_{DC,CS,avg} \quad (14)$$

where:

$M_{CO2,CS}$ is the charge-sustaining CO_2 mass emission of the CS type 1 test, g/km;

$M_{CO2,CS,nb,avg}$ is the average charge-sustaining CO_2 mass emission of n_{CS} CS type 1 tests based on the non-balanced CO_2 mass emissions according to equation 13 of this Appendix, g/km;

$EC_{DC,CS,avg}$ is the average charge-sustaining electric energy consumption of n_{CS} CS type 1 tests based on the REESS depletion according to equation 6 of this Appendix , Wh/km;

K_{CO2} is the CO_2 mass emission correction coefficient according to equation 12 of this Appendix, g/km/Wh/km.

2.6.2. In case of missing CO_2 mass emission correction coefficients for each phase m, the each phase CO_2 mass emission shall be calculated as follows:

$$M_{CO2,CS,m} = M_{CO2,CS,nb,avg,m} - K_{CO2} \times EC_{DC,CS,avg,m} \quad (15)$$

where:

$M_{CO2,CS,m}$ is the charge-sustaining CO_2 mass emission of phase m of the CS type 1 test, g/km;

$M_{CO2,CS,nb,avg,m}$ is the average charge-sustaining CO_2 mass emission of phase m of n_{CS} CS type 1 tests based on the non-balanced CO_2 mass emission of phase m, g/km;

$EC_{DC,CS,avg,m}$ is the average charge-sustaining electric energy consumption of phase m of n_{CS} CS type 1 tests based on the REESS depletion, Wh/km;

K_{CO2} is the CO_2 mass emission correction coefficient according to equation 12 of this Appendix, g/km/Wh/km.

2.6.3. In case of available CO_2 mass emission correction coefficients for each phase m, the each phase CO_2 mass emission shall be calculated as follows:

$$M_{CO2,CS,m} = M_{CO2,CS,nb,avg,m} - K_{CO2,m} \times EC_{DC,CS,avg,m} \quad (16)$$

where:

$M_{CO2,CS,m}$ is the charge-sustaining CO_2 mass emission of phase m of the CS type 1 test, g/km;

$M_{CO2,CS,nb,avg,m}$ is the average charge-sustaining CO_2 mass emission of phase m of n_{CS} CS type 1 tests based on the non-balanced CO_2 mass emission of phase m, g/km;

$EC_{DC,CS,avg,m}$ is the average charge-sustaining electric energy consumption of phase m of n_{CS} CS type 1 tests based on the REESS depletion, Wh/km;

$K_{CO2,m}$ is the CO_2 mass emission correction coefficient according to paragraph 2.5.3. of this Appendix, g/km/Wh/km;

m is the index for the phases of the considered test cycle.

1. This Appendix describes the test procedure for RCB compensation of CO_2 and fuel consumption measurement results when testing NOVC-HEV and OVC-HEV vehicles.

1.1. Separate CO_2 emission and fuel consumption correction coefficients shall be calculated separately for each phase of the WLTC and corrected to zero over each WLTC phase.

2. The fuel consumption correction coefficients (K_{fuel}) shall be defined as follows and might be supplied by the manufacturer :

2.1. The fuel consumption correction coefficient (K_{fuel}) shall be determined from a set of n measurements performed by the manufacturer. This set shall contain at least one measurement with $E_{REESSi} \leq 0$ and at least one with $E_{REESSi} > 0$ over the complete test cycle.

If the latter condition cannot be realised on the driving cycle used in this test, the responsible authority shall evaluate the statistical significance of the extrapolation necessary to determine the fuel consumption value at $\Delta E_{REESS} = 0$.

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:

$$K_{fuel} = \frac{(n \times \sum E_{REESS} \times FC_i - \sum E_{REESSi} \times \sum FC_i)}{n \times \sum E_{REESSi}^2 - (\sum E_{REESSi})^2} \quad (1)$$

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;

n is the number of measurements.

The fuel consumption correction coefficient shall be rounded to four significant figures. The statistical significance of the fuel consumption correction coefficient is to be evaluated by the responsible authority.

2.2. The fuel consumption correction coefficient shall be determined for the fuel consumption values measured over WLTC. This coefficient can be applied for each individual WLTC phase correction.

2.2.1. Without prejudice to the requirements of paragraph 2.1 of this Aappendix, at the manufacturer's request, separate fuel consumption correction coefficients for each individual WLTC phase may be developed.2.3. Fuel consumption at zero REESS energy balance (FC_0)

2.3. Fuel consumption at zero REESS energy balance (FC_0)

2.3.1. The fuel consumption FC_0 at $\Delta E_{REESS} = 0$ shall be determined by the following equation:

$$FC_0 = FC - K_{fuel} \times \Delta E_{REESS} \quad (2)$$

where:

FC_0 is the fuel consumption at $\Delta E_{REESS} = 0$, l/100 km;

FC is the fuel consumption measured during the test, l/100 km;

ΔE_{REESS} is the electricity balance measured during test, Wh/km.

2.3.2. Fuel consumption at zero REESS energy balance shall be calculated separately for each phase of the WLTC and corrected to zero over each WLTC phase.

2.3.3. Fuel consumption at zero REESS energy balance shall also be calculated for the complete WLTC and corrected to zero.

3. CO_2 emission correction coefficient (K_{CO_2}) shall be defined as follows and may be supplied by the manufacturer

3.1. The CO_2 emission correction coefficient (K_{CO_2}) shall be determined from a set of n measurements performed by the manufacturer. This set shall contain at least one measurement with $E_{REESSi} \leq 0$ and at least one with $E_{REESSi} > 0$ over the complete test cycle.

If the latter condition cannot be realised on the driving cycle used in this test, the responsible authority shall evaluate the statistical significance of the extrapolation necessary to determine the fuel consumption value at $\Delta E_{REESS} = 0$.

3.1.1. The CO_2 emission correction coefficient (K_{CO_2}) is defined as:

$$K_{CO_2} = \frac{(n \times \sum E_{REESS} \times M_i - \sum E_{REESSi} \times \sum M_i)}{n \times \sum E_{REESSi}^2 - (\sum E_{REESSi})^2} \quad (3)$$

where:

K_{CO_2} are the CO_2 emissions correction coefficient, g/km/Wh/km;

M_i are the CO_2 emissions measured during the i^{th} test, g/km;

E_{REESSi} is the electricity balance during the i^{th} test, Wh/km;

n is the number of measurements.

3.1.2. The CO_2 emission correction coefficient shall be rounded to four significant figures. The statistical significance of the CO_2 emission correction coefficient is to be judged by the responsible authority.

3.1.3. The CO_2 emission correction coefficient shall be determined for the CO_2 emission values measured over the WLTC. This coefficient may be applied for each individual WLTC phase correction.

3.1.3.1 Without prejudice to the requirements of paragraph 2.1 of this Aappendix, at the manufacturer's request, separate CO_2 emission correction coefficients for each individual WLTC phase may be developed.

3.1.4. CO_2 emissions at zero REESS energy balance shall be also calculated for complete WLTC and corrected to zero.

3.2. CO_2 emission at zero REESS energy balance (M_0)

3.2.1. The CO_2 emission M_0 at $\Delta E_{REESS} = 0$ shall be determined by the following equation:

$$M_0 = M - K_{CO_2} \times \Delta E_{REESS} \quad (4)$$

where:

M_0 are the CO_2 emissions at zero REESS energy balance, g/km;

K_{CO_2} are the CO_2 emissions correction coefficient, g/km/Wh/km;

ΔE_{REESS} is the electricity balance measured during test, Wh/km.

Annex 8 -Appendix 3

Measuring the electricity balance of NOVC-HEV and OVC-HEV batteries

1. Introduction

1.1. This Appendix defines the method and required instrumentation to measure the electricity balance of OVC-HEVs and NOVC-HEVs.

2. Measurement equipment and instrumentation

2.1. During the tests described in paragraph 3. of this Annex, the REESS current can be measured using a current transducer of the clamp-on or closed type. The current transducer (i.e. a current sensor without data acquisition equipment) shall have a minimum accuracy specified in paragraph 2.1.1. of Appendix 2 to Annex 6.

2.1.1. Alternatively to 2.1 above, the RCB determination method described in Annex 6, Appendix 2, paragraph 2.2. shall be applicable for all vehicle REESSs.

2.1.2. The current transducer shall be fitted on one of the cables directly connected to the REESS. In order to easily measure REESS current using external measuring equipment, manufacturers should preferably integrate appropriate, safe and accessible connection points in the vehicle. If that is not feasible, the manufacturer is obliged to support the responsible authority by providing the means to connect a current transducer to the wires connected to the REESS in the above described manner.

2.1.3. Output of the current transducer shall be sampled with a minimum sample frequency of 5 Hz. The measured current shall be integrated over time, yielding the measured value of RCB, expressed in ampere-hours (Ah).

2.2. A list of the instrumentation (manufacturer, model no., serial no.) used by the manufacturer to determine:

(a) When the minimum state of charge of the REESS has been reached during the test procedure defined in paragraph 3. of this Annex;

(b) The correction factors K_{fuel} and K_{CO_2} (as defined in Appendix 2 to this Annex);

(c) The last calibration dates of the instruments (where applicable) shall be provided to the responsible ~~technical~~ authority.

3. Measurement procedure

3.1. Measurement of the REESS current shall start at the same time as the test starts and shall end immediately after the vehicle has driven the complete driving cycle.

3.2. The RCB values of each phase shall be recorded.

Annex 8 -Appendix 4

Preconditioning and REESS charging conditions of PEVs and OVC-HEVs

1. This Appendix describes the test procedure for REESS and combustion engine preconditioning in preparation for:

   (a) Electric range, charge-depleting and charge-sustaining measurements when testing OVC-HEV; and

   (b) Electric range measurements as well as electric energy consumption measurements when testing PEV vehicles.

2. OVC-HEV combustion engine and REESS preconditioning

   When testing in charge-sustaining condition is followed by testing in charge-depleting condition, the charge-sustaining condition test and the charge-depleting test may be driven independently of one another. In that case, the vehicle shall be prepared as prescribed in paragraph 2.1.1. below before the charge-depleting test or the charge-sustaining test starts.

2.1. OVC-HEV combustion engine and REESS preconditioning when the test procedure starts with a charge-sustaining test

2.1.1. For preconditioning of the combustion engine, the OVC-HEV shall be driven over at least one WLTC. The manufacturer shall guarantee that the vehicle operates in a charge-sustaining condition.

2.1.2. When testing an OVC-HEV with driver-selectable operation mode, the preconditioning cycles shall be performed in the same operation condition as the charge-sustaining test as described in paragraph 3.2.5. of this Annex.

2.1.3. During the preconditioning cycle in paragraph 2.1.2. above, the charging balance of the traction REESS shall be recorded. The preconditioning shall be stopped at the end of the cycle when the break-off criterion ~~criteria~~ is fulfilled according to paragraph 3.2.4.5. of this Annex.

2.1.4. Alternatively, at the request of the manufacturer, the state of charge of the REESS for the charge-sustaining test can be set according to the manufacturer's recommendation in order to achieve a charge balance neutral charge-sustaining test.

In such a case, an additional ICE preconditioning procedure, such as that ~~as~~ applicable to conventional vehicles as described in paragraph 1.2.6. of Annex 6, ~~-~~may be applied.

2.1.5. Soaking of the vehicle shall be performed according to paragraph 1.2.7. of Annex 6. ~~Forced cooling down shall not be applied to vehicles preconditioned for the charge-depleting test.~~

Comment [DTF78]: Expert Proposal from JP: 03.11.14: Delete this

2.2. OVC-HEV combustion engine and REESS preconditioning when the test procedure starts with a charge-depleting test

2.2.1. For preconditioning of the combustion engine, the OVC-HEV shall be driven over at least one WLTC. The manufacturer shall guarantee that the vehicle operates in a charge-sustaining condition.

2.2.2.~~.~~ When testing an OVC-HEV with driver-selectable operation mode, the preconditioning cycles shall be performed in the same operation condition as the charge-sustaining test as described in paragraph 3.2.5. of this Annex.

2.2.3.~~.~~ Soaking of the vehicle shall be performed according to paragraph 1.2.7. of Annex 6. Forced cooling down shall not be applied to vehicles preconditioned for the test.

2.2.4. During soak, the electrical energy storage device shall be charged, using the normal charging procedure as defined in paragraph 2.2.5. below.

2.2.5. Application of a normal charge

2.2.5.1. The electrical energy storage device shall be charged:

(a) With the on-board charger if fitted; or

(b) With an external charger recommended by the manufacturer using the charging pattern prescribed for normal charging;

(c) In an ambient temperature as specified in ~~comprised according to~~ paragraph 1.2.2.2.2. of Annex 6. This procedure excludes all types of special charges that could be automatically or manually initiated, e.g. equalization charges or servicing charges. The manufacturer shall declare that during the test, a special charge procedure has not occurred.

2.2.5.2. End of charge ~~criteria~~criterion

The end of charge ~~criteria~~ criterion is reached when a fully charged REESS is detected by the on-board or external instruments.

3. PEV REESS conditioning

3.1. Initial charging of the REESS

Charging the REESS consists of discharging the REESS and applying a normal charge.

3.2~~1~~.1. Discharging the REESS

Discharge test procedure shall be performed according to the manufacturer's recommendation. The manufacturer will guarantee that the REESS is as fully depleted as is possible by the discharge test procedure.

3.3~~1~~.2. Application of a normal charge

The REESS shall be charged:

(a) With the on-board charger if fitted; or

(b) With an external charger recommended by the manufacturer using the charging pattern prescribed for normal charging;

(c) In an ambient temperature as specified in ~~comprised according to~~ paragraph 1.2.2.2.2. of Annex 6. This procedure excludes all types of special charges that could be automatically or manually initiated, e.g. equalization charges or servicing charges. The manufacturer shall declare that during the test, a special charge procedure has not occurred.

3.~~1.~~34. End of charge ~~criteria~~criterion

The end of charge ~~criteria~~ criterion is reached when a fully charged REESS is detected by the on-board or external instruments.

Annex 8 -Appendix 5

Utility factor (UF) for OVC-HEVs

1. Utility Factors (UFs) are ratios based on driving statistics and the ranges achieved in charge-depleting mode and charge-sustaining mode for OVC-HEVs and are used for weighting emissions, CO_2 emissions and fuel consumptions.

2. Each Contracting Party may develop its own UFs.

3. The methodology that is recommended for the determination of a UF curve based on driving statistics is described in SAE J2841 (SEPT 2010, Issued 2009-03, Revised 2010-09).

4. For the calculation of a fractional utility factor UF_j for the weighting of phase j the following equation shall be applied by using the coefficients from Table A8/7.

$$UF_j(d_j) = 1 - \exp\left(-\left(\sum_{i=1}^{k} C_i * \left(\frac{d_j}{d_n}\right)^i\right)\right) - \sum_{l=1}^{j-1} UF_l \qquad (1)$$

UF_j Utility factor for phase j;

d_j Measured distance at the end of phase j, km;

C_i i^{th} coefficient (Table A8/7);

d_n Normalized distance (Table A8/7), km;

k Amount of terms and coefficients in the exponent (Table A8/7);

j Number of considered phase;

i Number of considered term/coefficient;

$\sum_{l=1}^{j-1} UF_l$ Sum of calculated utility factors up to phase (j-1).

Comment [NSch40]: Added for more detailed description on Japanese request from WLTP-SG-EV webmeeting (13.02.2015).

Table A8/7

Parameters for the regional determination of fractional UF

Parameter	*Europe*	*Japan*	*US(fleet)*	*US(individual)*
d_n	800 km	400 km	399.9 mile	400 mile
C_1	26.25	11.8	10.52	13.1
C_2	-38.94	-32.5	-7.282	-18.7
C_3	-631.05	89.5	-26.37	5.22
C_4	5964.83	-134	79.08	8.15
C_5	-25095	98.9	-77.36	3.53
C_6	60380.2	-29.1	26.07	-1.34
C_7	-87517	NA	NA	-4.01
C_8	75513.8	NA	NA	-3.9
C_9	-35749	NA	NA	-1.15
C_{10}	7154.94	NA	NA	3.88

~~1. Utility Factors (UFs) are ratios based on driving statistics and the ranges achieved in charge-depleting mode and charge-sustaining modes for OVC-HEVs and are used for weighting emissions, CO_2 emissions and fuel consumptions.~~

~~2. Each Contracting Party may develop its own UFs.~~

[RESERVED:

Annex 8 - Appendix 6

Determining the range of PEVs on a per-phase basis]

[RESERVED:

Annex 9

Determination of system equivalence]

Page 7: [1] Comment [DTF22] Drafting Task Force Annex 8 03.03.2015 19:45:00

Observation of Iddo:
The most electric consuming mode is not necessarily the most suitable one for driving the WLTC and vice versa, so it needs to be clear what is the predominant requirement. One possible solution:
Within the modes available to the driver which are suitable for driving the applicable WLTC, the most electric energy consuming mode will be selected.

DTF-answer:
Solved according IR review of comments. But mode discussion still ongoing.

Page 7: [2] Comment [DTF23] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Suggestion:
To make this more specific, a requirement can be added to the expected use of such a mode, e.g. used less than 1% during the vehicle life

DTF:
suggests to keep current description, as already agreed in the group.

Page 7: [3] Comment [DTF24] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Content:
This term is not defined, and it is also not consistent with par. 3.1.1.6 where this is referred to as a propulsion system switch. It is recommended to harmonise the terminology and if possible to define it.

DTF:
Solved according IR review of comments. But need for consistency check within GTR by drafting coordinator. How is this defined/formulated for “conventional ICE”? Issue is the establishment/interruption of the driving readiness of the vehicle....

Page 7: [4] Comment [DTF27] Drafting Task Force Annex 8 03.03.2015 19:45:00

Dr. Tappe:
not consistent with 3.1.1.2. - fully press accelerator pedal

DTF:
Keep at it is

There is a need of finding a break-off-procedure for vehicles where the BreakOffCriteria cannot be defined (PHEV like REX without CS-capability)

Needs to be linked to BreakOffCriteria of PEV

Page 7: [5] Comment [DTF28] Drafting Task Force Annex 8 03.03.2015 19:45:00

Dr. Tappe:
is this vehicle classified as HEV ? No test results for cd test ? for incomplete WLTC - how to evaluate criteria pollutant emissions?

DTF:
is this vehicle classified as HEV ? YES

No test results for cd test ? for incomplete WLTC - how to evaluate criteria pollutant emissions?
Needs to be rediscussed and reinvestigated

Page 8: [6] Comment [DTF36] Drafting Task Force Annex 8 03.03.2015 19:45:00

Text Proposal:

"… Electric energy measurement can be stopped when the end of charge criterion (as defined in Annex 8 Appendix 4.2.5.2) is reached."

Page 8: [7] Comment [DTF37] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Suggestion:
Add the reference to this requirement

DTF:
Solved

Page 8: [8] Comment [DTF39] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Observation:
This text is double to the definition in section B, par. 3.3.7, and could therefore be left out.

DTF:
Inserted a reference to 3.3.7.

Page 8: [9] Comment [DTF40] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Suggestion:
which is most suitable for the applicable WLTC instead of best matches the target curve)

DTF:
Currently under discussion,
but ACEA suggestion: keep GTR as it is, just a slight amendment of the text is necessary…

Page 8: [10] Comment [DTF41] Drafting Task Force Annex 8 03.03.2015 19:45:00

Dr. Tappe:
how to determine this ?

ACEA answer:
- Manufacturer has to demonstrate it to the technical service
- Test conditions CD

Page 9: [11] Comment [DTF47] Drafting Task Force Annex 8 03.03.2015 19:45:00

Iddo Observation:
Par 3.2.5.1 describes the preconditioning for the CS test. Check if that is correct, or if the end of the CD test is the condition at which the CS test can follow immediately.
Note that if preconditioning between CD and CS test is necessary, these tests are effectively separated, so it would not be necessary to describe option 1 and 2.

DTF:
Text amendment already done in current GTR version

Page 9: [12] Comment [DTF50] Drafting Task Force Annex 8 03.03.2015 19:45:00

Dr. Tappe:
better "recharge" ?

DTF:
Agreed

Consistency check in GTR required!!!

Comments of Iddo on Annex 8 (chapter 4) and Task Force Drafting Answer/Proposal

4. Calculations

4.1. Emission compound calculations

Exhaust gases shall be analysed according to Annex 6. All equations shall apply to WLTC and WLTCcity tests.

4.1.1. OVC-HEV with and without operating mode switch

4.1.1.1. Charge-depleting mode emissions

The level of the emission compounds at charge-depleting $M_{i,CD}$ shall be calculated as follows:

$$M_{i,CD} = \frac{\sum_{j=1}^{k}(UF_j * M_{i,CD,j})}{\sum_{j=1}^{k} UF_j}$$

where:

$M_{i,CD,j}$ is the mass of the emissions compound measured during the j^{th} phase, ~~m~~g/km

i is the emissions compound

UF_i is the fractional utility factor of the j^{th} cycle phase, according to Appendix 5 of this Annex

j is the index number of the cycle phases up to the end of the transition cycle n

k is the number of cycle phases driven until the end of transition cycle n

4.1.1.2. Charge-sustaining mode emissions

4.1.1.2.1. The REESS charging balance correction (RCB) calculation is not required for the determination of emissions compounds.

4.1.1.3. Weighted emissions compounds

The weighted emissions compounds $M_{i,weighted}$ from the charge-depleting and charge-sustaining test results shall be calculated using the equation below:

$$M_{i,weighted} = \sum_{j=1}^{k}(UF_j * M_{i,CD,j}) + (1 - \sum_{j=1}^{k} UF_j) * M_{i,CS}$$

where:

$M_{i,weighted}$ is the utility factor-weighted exhaust emissions of each measured emission compound, ~~m~~g/km

i is the emissions compound

UFj is the fractional utility factor of the j^{th} phase according to Appendix 5 of this Annex

$M_{i,CD,j}$ are the compound mass emissions measured during the j^{th} charge-depleting phase, ~~m~~g/km

$M_{i,CS}$ are the compound mass emissions for the charge-sustaining test according to 3.2.5., ~~m~~g/km

j is the index number of the phases up to the end of the transition cycle n

k is the number of phases driven until the end of transition cycle n

Comment [IR1]: Suggestion: Since this is also the title of Annex 7, consider if this section in not more appropriate in that Annex

Comment [DTF2]: Proposal: "Calculations for pure and hybrid electric vehicles"

Comment [te3]: Meant are criteria pollutants, CO2 in section 4.2 – replace "Emission compound" by "Criteria pollutant emissions"

Comment [DTF4]: This will be adjusted to be in line with the wording of Annex 6 and 7. [emissions of gaseous compounds(§3.1.2), particulate matter, particle number, CO2 emissions, and fuel consumption] Annex 6 §1.1.1

Comment [te5]: What about PN and PM?

Comment [DTF6]: This is an issue we have to discuss within ACEA and SG EV.

Comment [te7]: Full?

Comment [DTF8]: Due to the discussions about phase specific values, it is up to the decision if the city cycle is still necessary. If not, the current wording can be kept. Otherwise it should be changed.

Comment [IR9]: Observation: The FC calculation is missing in this paragraph, but is referred to by par. 4.2.1.5 → solved according to review

Comment [DTF10]: All wording ... [1]

Comment [te11]: Better use terr ... [2]

Comment [DTF12]: Will be con ... [3]

Comment [IR13]: Content: ... [4]

Comment [DTF14]: To be in lin ... [5]

Comment [te15]: Why UF for c ... [6]

Comment [DTF16]: § was alrea ... [7]

Comment [te17]: Add $M_{i,CD}$ is t ... [8]

Comment [DTF18]: § was alrea ... [9]

Comment [te19]: Determinatio ... [10]

Comment [DTF20]: This is an ... [11]

Comment [IR21]: Content: ... [12]

Comment [DTF22]: Reference ... [13]

Comment [IR23]: Content: ... [14]

Comment [IR24]: Observation ... [15]

Comment [te25]: No formula (... [16]

Comment [DTF26]: Will be co ... [17]

Comment [te27]: Why weight ... [18]

Comment [DTF28]: Might be u ... [19]

Comment [IR29]: Content: ... [20]

Comment [DTF30]: To be in li ... [21]

Comment [te31]: Consistency.

Comment [te32]: Option 3, oth ... [22]

Comment [DTF33]: Of course ... [23]

Comment [IR34]: Observation ... [24]

4.1.2. NOVC-HEV with and without driver-selectable operating modes

4.1.2.1. Exhaust emissions shall be calculated as required for conventional vehicles according to Annex 7.

4.1.2.2. The charging balance correction (RCB) calculation is not required for the determination of emissions compounds.

4.2. CO_2 and Fuel Consumption Calculations

Exhaust gases shall be analysed according to Annex 6.

4.2.1. OVC-HEV with and without an operating mode switch

All equations shall apply to the WLTC and WLTCcity tests.

4.2.1.1. Charge-depleting CO_2 Emissions

The CO_2 values at charge-depleting mode, $CO_{2,CD}$ shall be calculated as follows:

$$CO_{2,CD} = \sum_{j=1}^{k}(UF_j * CO_{2,CD,j}) / \sum_{j=1}^{k} UF_j$$

where:

$CO_{2,CD}$ is the utility factor-~~adjusted~~ weighted mass of CO_2 emissions during charge-depleting mode, (g/km);

$CO_{2,CD,j}$ are the CO_2 emissions measured during the j^{th} charge-depleting phase, g/km;

UF_j the driving cycle and phase-specific utility factor according to Appendix 5 of this Annex;

j is the index number of each phase up to the end of the transition cycle n;

k is the number of phases driven up to the end of transition cycle n.

4.2.1.2. Charge-depleting fuel consumption

The fuel consumption values at charge depleting shall be calculated as follows:

$$FC_{CD} = \sum_{j=1}^{k}(UF_j * FC_{CD,j}) / \sum_{j=1}^{k} UF_j$$

where:

FC_{CD} is the utility factor-adjusted fuel consumption charge-depleting mode, l/100 km;

$FC_{CD,j}$ is the fuel consumption measured during the j^{th} charge-depletion phase, l/100 km;

UF_j is the driving cycle and phase-specific utility factor according to Appendix ~~2~~ 5 of this Annex;

j is the index number of each phase up to the end of the transition cycle n;

k is the number of phases driven up to the end of transition cycle n.

4.2.1.3. Charge-sustaining fuel consumption and CO_2 emissions

4.2.1.3.1. Test result correction as a function of REESS charging balance

The corrected values $CO_{2,CS,corrected}$ and $FC_{CS,FC,corrected}$ shall correspond to a zero electricity balance (RCB = 0), and shall be determined according to Appendix 2 of this Annex.

Comment [DTF35]: Take care about the consistency of "mode selectable switch".

Comment [DTF36]: proper wording: "REESS charging balance"

Comment [DTF37]: from my point of view "required" is not the right wording because it shall not be allowed (DEKRA validation phase 2)

Comment [IR38]: Suggestion: This is double to par. 4.1 and can be left out.

Comment [DTF39]: Correct. That is valid for the whole §4. Regarding the sentence in 4.1 this can be shifted between §4 and $4.1.

Comment [te40]: Full?

Comment [DTF41]: Due to the discussions about phase specific values, it is up to the decision if the city cycle is still necessary. If not, the current wording can be kept. Otherwise it should be changed.

Comment [IR42]: Observation: All remarks made to 4.1.1.1 also apply to this paragraph.

Comment [te43]: Replace by "Charge depleting mode CO2 emissions". Consistency

Comment [DTF44]: Will be reworked during formula review.

Comment [te45]: Use same layout! Consistency!

Comment [DTF46]: Will be reworked during formula review.

Comment [IR47]: Content: Harmonise this with similar parameter definitions above

Comment [DTF48]: Will be done.

Comment [IR49]: Content: Harmonise the definition of UF_j at all places where it is defined. The definition used here preferred over the previously used ones.

Comment [DTF50]: Will be done.

Comment [IR51]: Observation: All remarks made to 4.1.1.1 also apply to this paragraph. → solved according to review ... [25]

Comment [te52]: "Charge depleting mode fuel consumption"! Consistency!

Comment [DTF53]: Will be reworked during formula review.

Comment [te54]: Use same layout! Consistency!

Comment [DTF55]: Will be reworked during formula review.

Comment [te56]: Insert "during". Consistency!

Comment [IR57]: Content: ... [26]

Comment [IR58]: Suggestion: ... [27]

Comment [DTF59]: Consistency!

4.2.1.3.2. The electricity balance, measured using the procedure specified in Appendix ~~3~~ 2 of this Annex, is used as a measure of the difference in the vehicle REESS's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance is to be determined for the applicable WLTC driven.

4.2.1.3.3. The test results shall be the uncorrected measured values of $CO_{2,CS}$ and FC_{CS} in case any of the following applies:
(a) the manufacturer can prove that there is no relation between the energy balance and fuel consumption,
(b) ΔE_{REESS} as calculated from the test result corresponds to REESS charging,
(c) ΔE_{REESS} as calculated from the test result corresponds to REESS discharging and ΔE_{REESS}, as expressed as a percentage of the energy content of the fuel consumed over the cycle, as calculated in the equation below, is less than the RCB correction criteria, according to the following table:

$$\Delta E_{REESS} = \frac{0.0036 * RCB[Ah] * V_{REESS}}{E_{Fuel}} * 100[\text{per cent}] \leq \text{RCB correction criteria}$$

Cycle	WLTCcity (Low + Medium	WLTC (Low + Medium + High)	WLTC (Low + Medium + High + Extra High
RCB correction criteria [per cent]	1,5	1	0,5

where:

ΔE_{REESS}	is the change in the REESS energy content, Wh;
V_{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.

4.2.1.3.4. ~~Where~~ If RCB corrections of CO_2 and fuel consumption measurement values are required, the correction procedure described in Appendix 2 of this Annex shall be used.

4.2.1.4. Utility factor Weighted CO_2 Emissions

The weighted CO_2 emissions from the charge-depleting and charge-sustaining test results shall be calculated using the equation below:

$$CO_{2,weighted} = \sum_{j=1}^{k}(UF_j * CO_{2,CD,j}) + (1 - \sum_{j=1}^{k} UF_j) * CO_{2,CS}$$

where:

$CO_{2,weighted}$	are the utility factor-weighted CO_2 emissions, g/km;
UF_j	is the fractional utility factor of the j^{th} phase;
$CO_{2,CD,j}$	are the CO_2 emissions measured during the j^{th} charge-depleting phase, g/km;
$CO_{2,CS}$	are the CO_2 emissions for the charge-sustaining test according to paragraph 4.1.1.3., g/km;
j	is the index number of each phase up to the end of the transition cycle n;
k	is the number of phases driven up to the end of transition cycle n.

Comment [IR60]: Content: Wrong reference → solved according to review

Comment [te61]: Better "full WLTC".?

Comment [DTF62]: Due to the discussions about phase specific values, it is up to the decision if the city cycle is still necessary. If not, the current wording can be kept. Otherwise it should be changed.

Comment [te63]: How?

Comment [DTF64]: The process of evidence could be defined. Will be discussed.

Comment [te65]: Insert line break to have formula as separate sentence.

Comment [DTF66]: Already considered in the latest GTR version.

Comment [te67]: conventional fuel e.g. gasoline – how is this determined? Formula?

Comment [DTF68]: Will be added. Waiting for response of St. Lutz.

Comment [IR69]: Suggestion: This is exactly the same text as in par. 3.6 of Appendix 2 in Annex 6. It is highly recommended to be deleted, and replaced by a reference to that paragraph.

Comment [DTF70]: Maybe the criteria will be shifted to Appendix 2 or an additional Appendix will be inserted.

Comment [IR71]: Suggestion: This is double to the statement in par. 4.2.1.3.1., so one of these can be deleted. → solved according to review

Comment [IR72]: Observation: All remarks made to 4.1.1.1 also apply to this paragraph.

Comment [DTF73]: Will be considered.

4.2.1.5. Utility factor Weighted FC ~~Emissions~~

The weighted fuel consumption from the charge-depleting and charge-sustaining test results shall be calculated using the equation below:

$$FC_{weighted} = \sum_{j=1}^{k}(UF_j * FC_{CD,j}) + (1 - \sum_{j=1}^{k} UF_j) * FC_{CS}$$

where:

$FC_{weighted}$	is the utility factor-weighted fuel consumption, l/100 km;
UF_j	is the fractional utility factor of the j^{th} phase;
$FC_{CD,j}$	is the fuel consumption measured during the j^{th} charge-depleting phase, l/100 km;
FC_{CS}	is the fuel consumption measured during the charge-sustaining test according to paragraph 4.1.1.3., l/100 km;
j	is the index number of each phase up to the end of the transition cycle n;
k	is the number of phases driven up to the end of transition cycle n.

4.2.2. NOVC-HEV with and without driver-selectable operating modes

4.2.2.1. Exhaust gases shall be analysed according to Annex 6.

4.2.2.2. Charge-sustaining fuel consumption and CO_2 emissions shall be calculated according to section 4.2.1.3. of this Annex.

4.2.2.3. Test result correction as a function of REESS charging balance

The corrected values $CO_{2,CS,corrected}$ and $FC_{CS,FC,corrected}$ shall correspond to a zero energy balance (RCB = 0), and shall be determined according to Appendix 2 of this Annex.

All installed REESS shall be considered for RCB correction of CO2 and fuel consumption values. The sum of ΔE_{REESS} shall be the sum of RCB(i) multiplied by respective nominal voltage (i) of all REESSs.

4.2.2.3.1 The electricity balance, measured using the procedure specified in Appendix 3 to this Annex, is used as a measure of the difference in the vehicle REESS's energy content at the end of the cycle compared to the beginning of the cycle. The electricity balance is to be determined for the applicable WLTC driven.

4.2.2.3.2. The test results shall be the uncorrected measured values of $CO_{2,CS}$ and FC_{CS} in case any of the following applies:
(a) the manufacturer can prove that there is no relation between the energy balance and fuel consumption,
(b) ΔE_{REESS} as calculated from the test result corresponds to REESS charging,
(c) ΔE_{REESS} as calculated from the test result corresponds to REESS discharging and ΔE_{REESS}, as expressed as a percentage of the energy content of the fuel consumed over the cycle, as calculated in the equation below, is smaller than the RCB correction criteria, according to the following table:

$$\frac{0.0036 \times \sum_{i=1}^{z}(RCB_i \times V_{REESSi})}{E_{fuel}} \times 100 \leq \text{RCB correction criteria}$$

Comment [IR74]: Observation:
All remarks made to 4.1.1.1 also apply to this paragraph.

Comment [DTF75]: Will be considered.

Comment [IR76]: Content:
FC is not an emission(!)→ solved according to review

Comment [te77]: Different layout compared to previous §!

Comment [DTF78]: Already done in the latest version. Will be checked twice during formula check.

Comment [IR79]: Observation:
The FC is not determined in par. 4.1.1.3, but should be added there. → solved according to review

Comment [IR80]: Suggestion:
This is double to par. 4.1 and can be left out.

Comment [DTF81]: Correct. That is valid for the whole §4. Regarding the sentence in 4.1 this can be shifted between §4 and $4.1.

Comment [IR82]: Observation:
According to the previous paragraph 4.2.2.2, the calculations of section 4.2.1.3 have to be followed. In that paragraph the RCB correction is already applied.
In this paragraph 4.2.2.3, the whole procedure is repeated. It is recommended that 4.2.2.3 and its subparagraphs are deleted, the reference to 4.2.1.3 is sufficient.
Note that the only difference between 4.2.2.3 and 4.2.1.3 is the yellow highlighted part. This needs to stay in.

Comment [DTF83]: Maybe the criteria will be shifted to Appendix 2 or an additional Appendix will be inserted.

Comment [te84]: Identical to 4.2.1.3.2!

Comment [DTF85]: Maybe the criteria will be shifted to Appendix 2 or an additional Appendix will be inserted.

Comment [te86]: Identical to 4.2.1.3.3!

Comment [DTF87]: Maybe the criteria will be shifted to Appendix 2 or an additional Appendix will be inserted.

Cycle	WLTCcity (Low + Medium	WLTC (Low + Medium + High)	WLTC (Low + Medium + High + Extra High)
RCB correction criteria [per cent]	1,5	1	0,5

where:

V_{REESSi} is the nominal REESS voltage for i^{th} REESS, V;
RCB_i is the charging balance over the whole cycle for the i^{th} REESS, Ah;
E_{Fuel} is the energy content of the consumed fuel, MJ.
i index of REESS
z number of installed REESS

4.2.2.3.3. ~~Where~~ If RCB corrections of CO_2 and fuel consumption measurement values are required, the procedure described in Appendix 2 of this Annex shall be used.

4.3. Electric Energy Consumption Calculations

4.3.1. OVC-HEV

4.3.1.1. Utility factor-weighted total AC electric energy consumption $EC_{weighted}$ including charging losses shall be calculated using the following equations:

$$EC_{weighted} = \sum_{j=1}^{k} (UF_j * EC_{CD,j})$$

$$EC_{CD,j} = \frac{RCB_j}{D_j * \sum_{j=1}^{k} RCB_j} * E_{AC}$$

where:

$EC_{weighted}$ is the utility factor-weighted total energy consumption, Wh/km;
UF_j is the driving cycle and phase-specific utility factor according to Appendix 5 of this Annex;
$EC_{CD,j}$ is the calculated fraction of E_{AC} used in the j^{th} phase during the charge-depleting test, Wh/km;
RCB_j is the measured charge balance of the traction REESS of the j^{th} phase during the charge-depleting test, Ah;
D_j is the distance driven in the j^{th} phase during the charge-depleting test, km;
E_{AC} is the measured recharged electric energy from the mains, Wh;
j is the index number of each phase up to the end of transition cycle n;
k is the number of phases driven up to the end of transition cycle n.

4.3.1.2. Electric energy consumption including charging losses

4.3.1.2.1. Recharged electric energy E in Wh and charging time measurements shall be recorded.

4.3.1.2.2. Electric energy consumption EC is defined by the equation:

Comment [te88]: § 4.2.1.3.3 considers only one REESS! Here more than one REESS is considered!

Comment [DTF89]: All REESS have to be regarded. Potential inconsistency will be considered.

Comment [te90]: Already stated in § 4.2.2.3 that Appendix 2 shall be used – can be deleted.

Comment [DTF91]: That is true. Can be deleted.

Comment [IR92]: Suggestion: This is double to the statement in par. 4.2.2.3., so one of these can be deleted. → solved according to review

Comment [IR93]: Observation: All remarks made to 4.1.1.1 also apply to this paragraph.

Comment [DTF94]: Will be considered.

Comment [te95]: E_{AC}

Comment [DTF96]: Already corrected.

Comment [te97]: Why charging time?

Comment [DTF98]: Can be deleted. Not necessary any more.

Comment [IR99]: Observation: This is already required in the relevant paragraphs (3.2.4.6, 3.2.5.4, 3.4.2.3.1.4), so it can be left out here

Comment [DTF100]: We have to decide, whether it is better to keep it in chapter 4 or keep it in chapter 3.

Comment [te101]: Where is EC used?

Comment [DTF102]: Might be used for customer information.

$$EC = E_{AC} / EAER$$

where:
EC is the electric energy consumption, Wh/km;
E_{AC} is the recharged electric energy from the mains, Wh;
EAER is the equivalent all-electric range according to paragraph 4.4.1.~~3~~2., km.

4.3.1.3. Charge-depleting AC electric energy consumption EC_{CD} including charging losses

$$EC_{CD} = \frac{EC_{weighted}}{\sum_{j=1}^{k} UF_j}$$

where:
$EC_{weighted}$ is the electric energy consumption, Wh/km;
EC_{CD} is the recharged electric energy from the grid including charging losses, Wh;
UF_i is the driving cycle and phase-specific utility factor according to Appendix 5 of this Annex;
j is the index number of each phase up to the end of transition cycle n;
k is the number of phases driven up to the end of transition cycle n.

4.3.2. Pure electric vehicle (PEV)

4.3.2.1. Recharged electric energy E in Wh and charging time measurements shall be recorded.

4.3.2.2. The electric energy consumption EC including charging losses is defined by the equation:

$$EC = E_{AC} / AER$$

where:
EC is the electric energy consumption, Wh/km;
E_{AC} is the recharged electric energy from the mains, Wh;
AER is the all-electric range as defined in ~~B.3. Definitions of this GTR~~par. 4.4.2.1 of this Annex.

4.4. Electric Range

4.4.1. OVC-HEV
All equations apply to the WLTC and WLTCcity cycle tests.

4.4.1.1. All-electric range, AER
The distance driven over consecutive WLTCs using only the REESS until the combustion engine starts consuming fuel for the first time shall be measured and be rounded to the nearest whole number.

4.4.1.2. Equivalent all-electric range, EAER

4.4.1.2.1. EAER shall be calculated as follows:

Comment [te103]: Here EAER is used! Anywhere else?

Comment [DTF104]: No. But EAER can also be used for customer information.

Comment [IR105]: Observation: Check if there should not be also a calculation for ECcity, based on EAERcity Note that the reference is wrong. → solved according to review

Comment [IR106]: Observation: All remarks made to 4.1.1.1 also apply to this paragraph.

Comment [DTF107]: Will be considered.

Comment [IR108]: Observation: Since the sum of UF_j is 1, this formula reads: $EC_{CD} = EC_{weighted}$ Note: if the sum of UF_j is not 1, the formula in 4.3.1.1. for $EC_{weighted}$ will be incorrect (refer to the comment in 4.1.1.1 about the index numbering)

Comment [DTF109]: Equation is correct. The sum of UFj only considers fractional UF parts from charge depleting test. Hence sum is not equal to 1.

Comment [IR110]: Observation: This is already required in the relevant paragraphs (3.2.4.6, 3.2.5.4, 3.4.2.3.1.4), so it can be left out here

Comment [DTF111]: We have to decide, whether it is better to keep it in § 4 or keep it in § 3. The same as in [3] 4.3.1.2.1.

Comment [te112]: Here AER is used! Anywhere else?

Comment [DTF113]: No. But could be used e.g. for customer information.

Comment [IR114]: Observation: Check if there should not be also a calculation for ECcity, based on AERcity (it says in 4.1 that all equations apply to WLTC and WLTCcity cycles, but the related parameters should also be specified, such as AEARcity, ECcity, etc.

Comment [IR115]: Content: Use the paragraph where this parameter is determined for the reference. → solved according to review

Comment [DTF116]: Due to the discussions about phase specific values, it is up to the decision if the city cycle is still necessary. If not, the current wording can be kept. Otherwise it should be changed.

Comment [IR117]: Suggestion: This is already required by par.3.2.9.2, so it can be left out here.

Comment [DTF118]: This will be discussed if it will be deleted in §3 or §4.

$$EAER = \left(\frac{CO_{2,CS} - CO_{2,CDavg}}{CO_{2,CS}}\right) * R_{cdc}$$

where:

$$CO_{2,CD,avg} = \frac{\sum_{j=1}^{k} CO_{2,CD,j}}{\sum_{j=1}^{k} D_j}$$

and:

EAER	is the equivalent all-electric range EAER, km;
$CO_{2,CS}$	are the CO_2 emissions during the charge-sustaining test, g/km;
$CO_{2,CD,j}$	are the CO_2 emissions in the j^{th} phase during the charge-depletion test, g;
D_j	is the distance driven in the j^{th} phase during the charge-depletion test, km;
R_{cdc}	is the charge-depleting cycle range, km;
j	is the index number of each phase up to the end of the transition cycle n;
k	is the number of phases driven up to the end of the transition cycle n.

4.4.1.3. Charge-depleting cycle range R_{cdc}

The distance from the beginning of the charge-depleting test to the end of the last cycle prior to the cycle or cycles satisfying the break-off criteria shall be measured. This shall include the distance travelled during the transition cycle where the vehicle operates in both depleting and sustaining modes. If the charge-depleting test possesses a transition range, the R_{cdc} shall include those transition cycles or cycles.

4.4.1.4. Actual charge-depleting cycle range R_{cda}

$$R_{cda} = \sum_{j=1}^{n-1} D_{j,cycle} + \left(\frac{CO_{2,CS} - CO_{2,n,cycle}}{CO_{2,CS} - CO_{2,CD,average,n-1}}\right) \times D_n$$

where:

R_{cda}	is the actual charge-depleting range, km;
$CO_{2,CS}$	are the CO_2 emissions during the charge-sustaining test, g/km;
$CO_{2,n,cycle}$	are the CO_2 emissions over the n^{th} drive cycle in charge-depleting operating condition, g/km;
$CO_{2,CD,average,n-1}$	are the average CO_2 emissions in charge-depleting operating condition until the n-1^{th} drive cycle, g/km;
$D_{j,cycle}$	is the test distance travelled during j^{th} drive cycle, km;
D_n	is the test distance travelled during the n^{th} drive cycle in charge-depleting operating condition, km;
j	is the index number of each whole cycle up to the end of transition cycle n;
n	is the number of whole cycles driven including transition cycle n.

4.4.2. PEV

4.4.2.1. All-electric range, AER

The distance driven over consecutive WLTCs until the break-off criteria is reached shall be measured and be rounded to the nearest whole number according to paragraph 3.4.2.43.1.3.

4.4.2.2. All-electric city range, AERcity

The distance driven over consecutive WLTCcity cycles until the break-off criteria is reached shall be measured and be rounded to the nearest whole number according to paragraph 3.4.2.3.1.3.

Comment [IR119]: Suggestion: All emission parameters in the GTR are in units of g/km. In this case, $CO_{2,CD,j}$ is specified in units of g to make this formula work. Suggestion is to specify this parameter also in g/km, and multiply $CO_{2,CD,j}$ by D_j in the formula

Comment [DTF120]: Due to the consistency, the equation will be adjusted.

Comment [IR121]: Observation: This whole paragraph is identical to 3.2.9.5.1 and can therefore be deleted. If there is a good reason to keep it in, please note the other remarks made at 3.2.9.5.1.

Comment [DTF122]: Correct. We have to check if we delete in §3 or §4.

Comment [IR123]: Suggestion: It is recommended to add a formula for this parameter, similar to that in par. 4.4.1.2.1

Comment [DTF124]: Seems to be reasonable. Will be added.

Comment [te125]: How is this determined? Compare with Figure A8 App 1a/1.

Comment [DTF126]: Is the distance travelled in the transient cycle → ~23.3km

Comment [IR127]: Suggestion: This is already required by 3.4.2.3.1.2 so it can be left out here. Note that also the reference is wrong

Comment [DTF128]: Correct. We have to check if we delete in §3 or §4.

Page 1: [1] Comment [DTF10] **Drafting Task Force Annex 8** **28.01.2015 10:53:00**

All wordings including “mode selectable switch” have to be checked while next review.

Page 1: [2] Comment [te11] **Dr. Tappe** **29.01.2015 09:33:00**

Better use term “Drive selectable operating modes” as elsewhere

Page 1: [3] Comment [DTF12] **Drafting Task Force Annex 8** **29.01.2015 10:25:00**

Will be considered during consistency check!

Page 1: [4] Comment [IR13] **Iddo Riemersma** **28.01.2015 10:38:00**

Content:
Specify the used parameter → solved according to review

Page 1: [5] Comment [DTF14] **Drafting Task Force Annex 8** **28.01.2015 15:20:00**

To be in line with Annex 7 it will be discussed to delete symbols from the header.

Page 1: [6] Comment [te15] **Dr. Tappe** **29.01.2015 09:40:00**

Why UF for criteria pollutants? Why phase specific UF?

Page 1: [7] Comment [DTF16] **Drafting Task Force Annex 8** **29.01.2015 10:27:00**

§ was already deleted. The reason for phase specific UF is the weighting of each phase.

Page 1: [8] Comment [te17] **Dr. Tappe** **29.01.2015 10:28:00**

Add $M_{i,CD}$ is the utility factor adjusted mass of emissions during charge depleting mode, g/km

Page 1: [9] Comment [DTF18] **Drafting Task Force Annex 8** **29.01.2015 10:29:00**

§ was already deleted in the latest revision.

Page 1: [10] Comment [te19] **Dr. Tappe** **29.01.2015 09:38:00**

Determination of criteria pollutant emissions separately for each WLTP phase – what about PM and PN?

Page 1: [11] Comment [DTF20] **Drafting Task Force Annex 8** **29.01.2015 10:30:00**

This is an issue we have to discuss within ACEA and SG EV.

Page 1: [12] Comment [IR21] **Iddo Riemersma** **28.01.2015 10:38:00**

Content:
This has to be harmonised to the unit applied within Annex 6, which is g/km → solved according to review

Page 1: [13] Comment [DTF22] **Drafting Task Force Annex 8** **28.01.2015 11:19:00**

Reference to Anney7 § 3.1.2 (all compounds are listed for different types of reference fuel).

Page 1: [14] Comment [IR23] **Iddo Riemersma** **28.01.2015 10:38:00**

Content:
For consistency, add the word ‘cycle’ to ‘phase’ where appropriate
Applies to all occurrences of this word in Annex 8 → solved according to review

Page 1: [15] Comment [IR24] **Iddo Riemersma** **28.01.2015 10:39:00**

Observation:
The ‘j’ is used as an index for the cycle phase UF, but also for the number of cycle phases driven until the end of the transition cycle.
Example: If the applicable WLTC has e.g. 3 phases, and is driven 4 times to the transition cycle, then there are 3 fractional UF_j: UF_1, UF_2 and UF_3. However, k = (3 x 4 =) 12, so j will go from 1 to 12. It is recommended to use different index indicators → solved according to review

Page 1: [16] Comment [te25] **Dr. Tappe** **29.01.2015 09:43:00**

No formula or reference given –include a §like this one: 4.1.2.1 Exhaust emissions shall be calculated as required for conventional vehicles according to Annex 7.

Page 1: [17] Comment [DTF26] **Drafting Task Force Annex 8** **29.01.2015 10:50:00**

Will be considered! For the purpose of a clear overview, might be kept.

Page 1: [18] Comment [te27] **Dr. Tappe** **29.01.2015 09:44:00**

Why weighted criteria pollutant emissions?

Page 1: [19] Comment [DTF28] **Drafting Task Force Annex 8** **29.01.2015 10:51:00**

Might be used in the future e.g. for taxation.

Page 1: [20] Comment [IR29] **Iddo Riemersma** **28.01.2015 10:39:00**

Content:
Insert parameter → solved according to review

Page 1: [21] Comment [DTF30] **Drafting Task Force Annex 8** **28.01.2015 15:23:00**

To be in line with Annex 7 it will be discussed to delete symbols from the header.

Page 1: [22] Comment [te32] **Dr. Tappe** **29.01.2015 09:46:00**

Option 3, other options not allowed?

Page 1: [23] Comment [DTF33] **Drafting Task Force Annex 8** **29.01.2015 10:53:00**

Of course this is also valid for all options including a charge sustaining test. Will be corrected after §3 is re-worked.

Page 1: [24] Comment [IR34] **Iddo Riemersma** **28.01.2015 10:39:00**

Observation:
Same remark as for 4.1.1.1 → solved according to review

Page 2: [25] Comment [IR51] **Iddo Riemersma** **28.01.2015 10:39:00**

Observation:
All remarks made to 4.1.1.1 also apply to this paragraph. → solved according to review

Page 2: [26] Comment [IR57] **Iddo Riemersma** **28.01.2015 10:39:00**

Content:
Incorrect reference → solved according to review

Page 2: [27] Comment [IR58] **Iddo Riemersma** **28.01.2015 10:39:00**

Suggestion:
Zero charging balance seems more appropriate, since RCB is REESS charging balance. (see also remark at 3.5 of appendix 2 in Annex 6)
Applies to all occurrences of ‘electricity balance’ → solved according to review