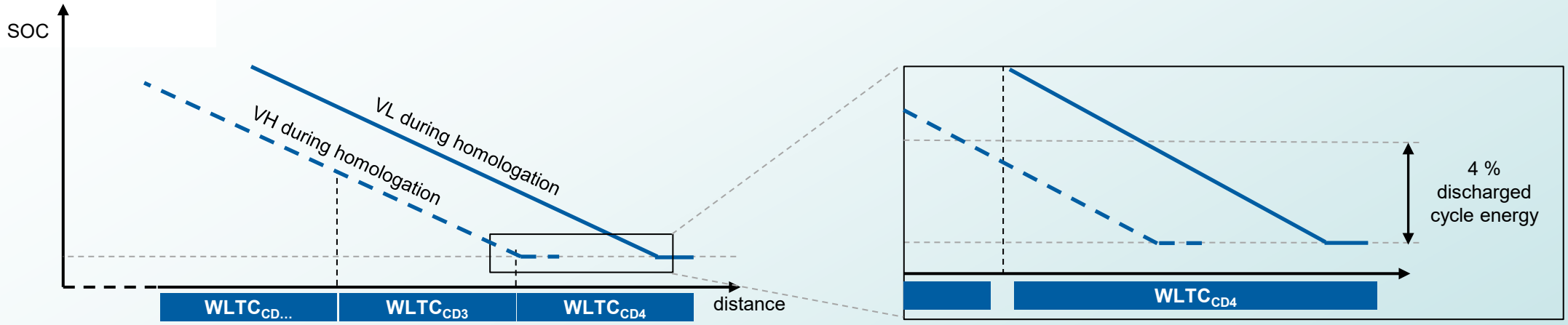
EAER calculation VH and VL



	Vehicle L	**Vehicle H**
RCDC-nr.	4 (→ WLTC$_{CD4}$ is transition cycle)	3 (→ WLTC$_{CD3}$ is transition cycle)

Current situation:

- For several calculation, the approach to use the number of CD cycles from vehicles L is already implemented as e.g. for $EC_{AC,CD}$ (Annex B8, §4.3.1.)
- The implementation of this approach has been missed to be integrated for EAER (see next slide)
- Interpolation method working for the R_{CDC} difference of 1 cycle (between VH and VL) but manufacturer need to add a safety margin that is not caused by physical energy but by the calculation method (lessons learned)

Overview of values* where “VL approach” is applied

*note: AER not in the tables as triggered by engine start

Except of FE_{CD} and EAER based values, all interpolated CD or weighted values apply the VL approach:

Parameter	Application of VL approach	Interpolation method
$M_{CO2,CD}$ (both levels)	Yes	Yes
$M_{CO2,weighted}$ (Level 1A)	Yes	Yes
FC_{CD} (Level 1A)	Yes	Yes
FE_{CD} (Level 1B)	No	Yes
$FC_{weighted}$ (Level 1A)	Yes	Yes
$EC_{AC,CD}$ (Level 1A)	Yes	Yes
$EC_{AC,weighted}$ (Level 1A)	Yes	Yes
EC (both levels) → (result of E_{AC} divided by EAER)	No	Yes
EC_p (both levels) → (result of E_{AC} divided by $EAER_p$)	No	Yes
EAER (both levels)	No	Yes
$EAER_p$ (both levels)	No	Yes

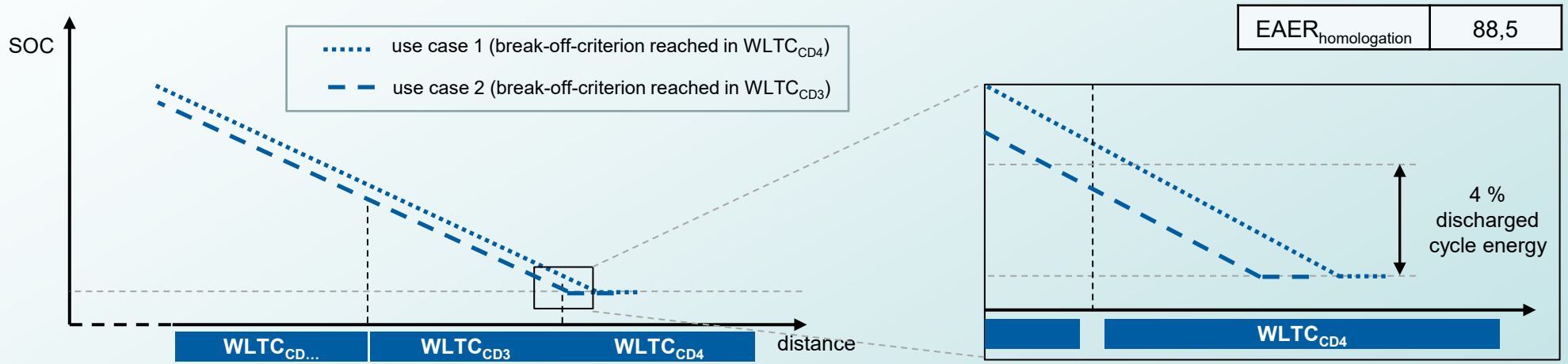
Only values, which are not using the interpolation method, are not appling the VL approach:

Parameter	Application of VL approach	Interpolation approach
$PN_{weighted}$ (both levels)	No	No
$PM_{weighted}$ (both levels)	No	No
R_{CDA} (both levels)	No	No

Impacts of different R_{CDC} on EAER

Break-off criterion for the charge-depleting test (less than 4% of cycle energy from REESSs) influences R_{CDC}

→ resulting EAER different → resulting SOCR indicator different → **Will lead to problems in context of EVE-GTR**



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

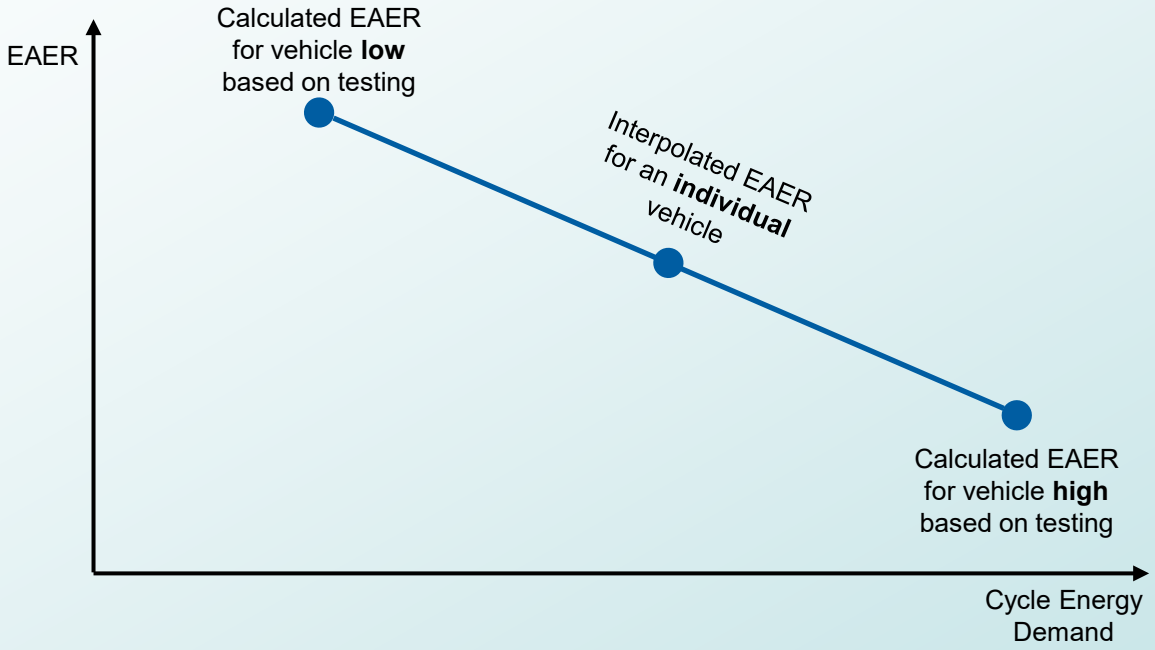
$$EAER_{measured} = \left(\frac{M_{CO2,CS} - M_{CO2,CD,avg}}{M_{CO2,CS}}\right) \times R_{cdc}$$

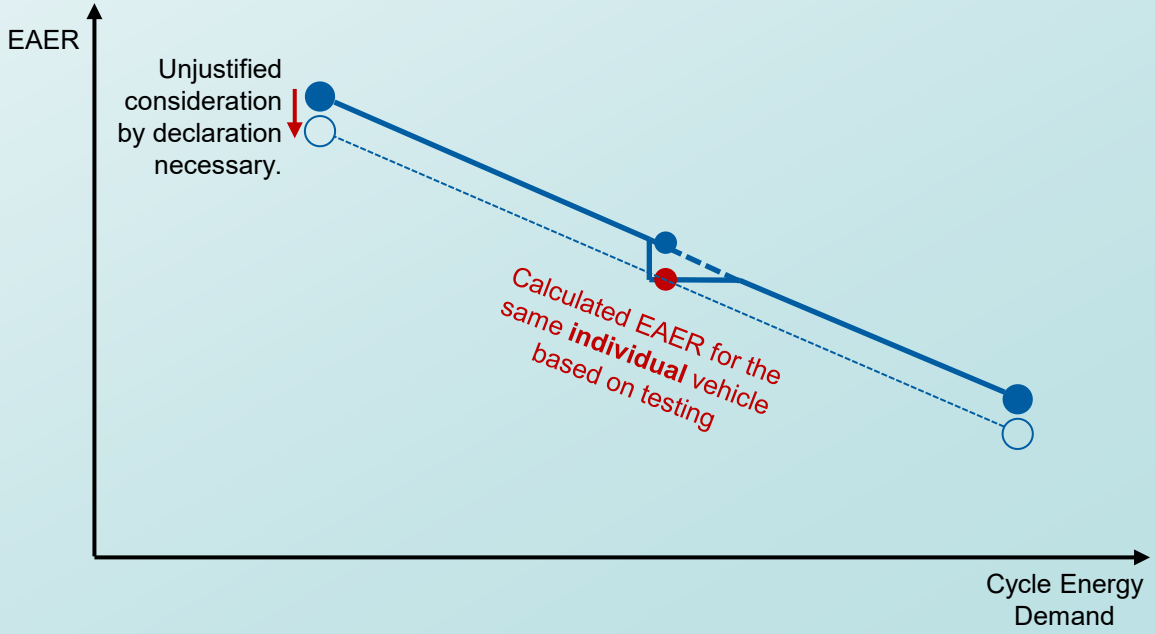
	<u>Use case 1:</u> more than 4 % cycle energy discharged in WLTC$_{CD,4}$	**<u>Use case 2:</u> less than 4% cycle energy discharged in WLTC$_{CD,4}$**
CO2_CD1	0	0
CO2_CD2	0	0
CO2_CD3	0	0
CO2_CD4	96	96
CO2_CS	100	100
RCDC-nr.	4 (→ WLTC$_{CD4}$ is transition cycle)	3 (→ WLTC$_{CD3}$ is transition cycle)
RCDC	93,2	69,9
EAER$_{ISC}$	70,832	69,9
SOCR (EVE-GTR)	80	78,94736842

Impacts of different R_{CDC} on EAER

The interpolation approach assumes an linear character between low and high what is correct from a physical perspective, but…

… if an individual vehicle tested e.g. for ISC without keeping the R_{CDC} constant, there is a **non-physical-based** difference between the interpolated EAER and the calculated EAER based on a test. The only solution to cover this is to consider it with the declaration but the manufacturer should not be forced to cover methodical weak points.





Required action items

Action item ISC:

In context of an individual vehicle @ ISC (e.g. EVE-GTR) it is necessary to refer to the R_{CDC}-value determined during type approval.

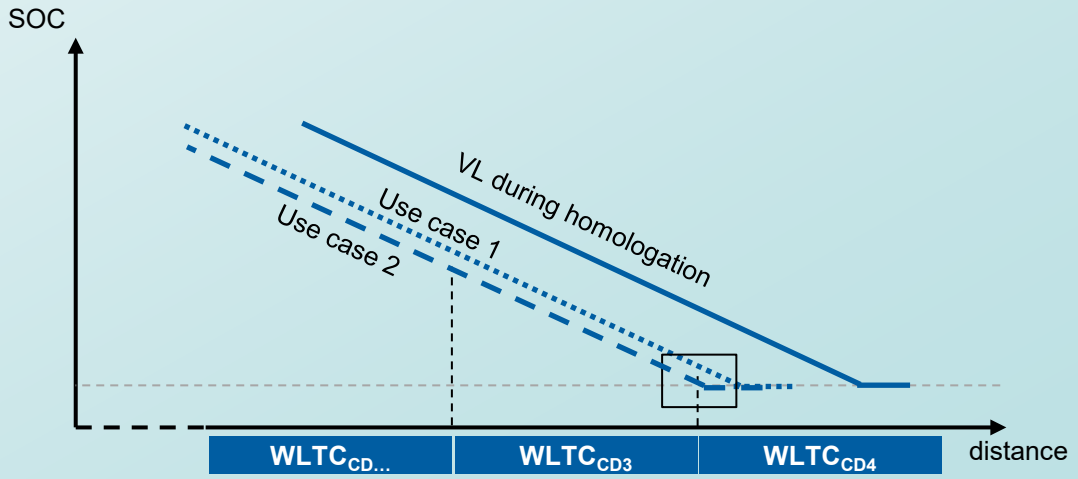
→ This eliminates the impact of the break-off-criterion on R_{CDC} and therefore on EAER for ISC-testing.

Action item homologation:

→ In case of different R_{CDC}-values at homologation for VH and VL, some individual vehicles close to the break-off criterion (4% threshold) would lose EAER caused by the calculation method

→ Way forward to resolve this problem is just one R_{CDC}-value for the purpose of EAER calculation within one IP-family → R_{CDC} of vehicle L

	Homologation	Use case 1 ·····	Use case 2 – –
Use case	VL @Type Approval (TA)	Vehicles with the same R_{CDC}-value than VL@TA (e.g.: VH@TA or any individual vehicle in IPF)	Vehicles with different R_{CDC}-value than VL@TA (e.g.: VH@TA or any individual vehicle in IPF or vehicles during ISC)
R_{CDC}-value	4 x WLTC ($WLTC_{CD4}$ is transition cycle)	4 x WLTC ($WLTC_{CD4}$ is transition cycle)	3 x WLTC ($WLTC_{CD3}$ is transition cycle)
Action	No amendment required as this is reference.	No amendment required as R_{CDC} identical to reference.	Amendment required as R_{CDC} different to reference.



Required changes in UN R 154 (Annex B8)

The following paragraphs in UN-R-154 would need to be amended:

- Annex B8, Paragraph 4.4.3. (Charge-depleting cycle range for OVC-HEVs) → **Bold** text to be added

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

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

- Amend UN R 154, Annex B8, §4.4.4.1. Determination of cycle-specific equivalent all-electric range
- Amend UN R 154, Annex B8, §4.4.6.1. Determination of cycle-specific equivalent all-electric range

→ Bold text to be added at the end of both paragraphs:

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