

N. Schütze, 19.03.2014

PHASE SPECIFIC CONSUMPTION FOR OVC- HEV BASED ON THE PROPOSAL FROM JAPAN.

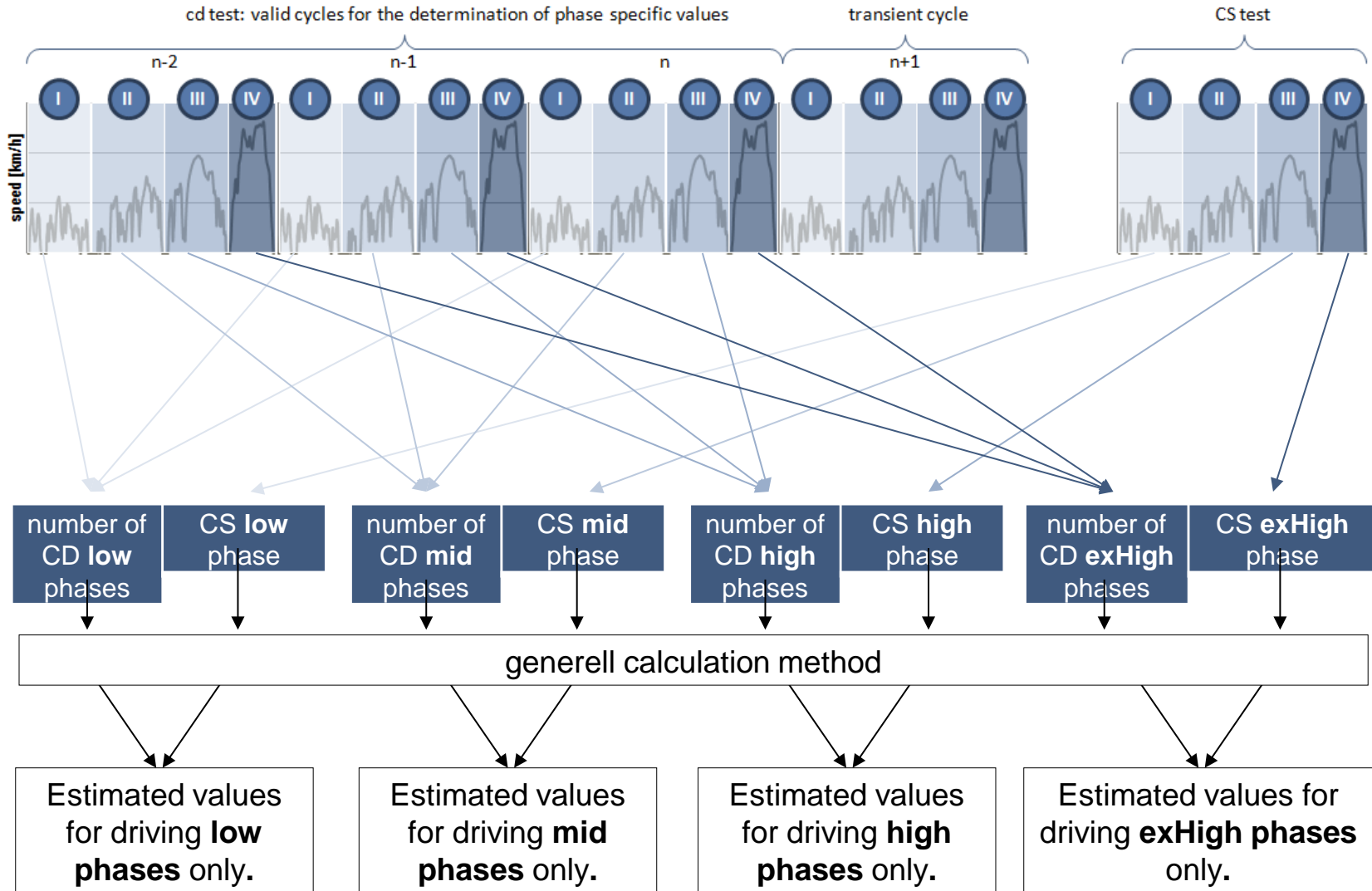
**BMW
GROUP**



Rolls-Royce
Motor Cars Limited

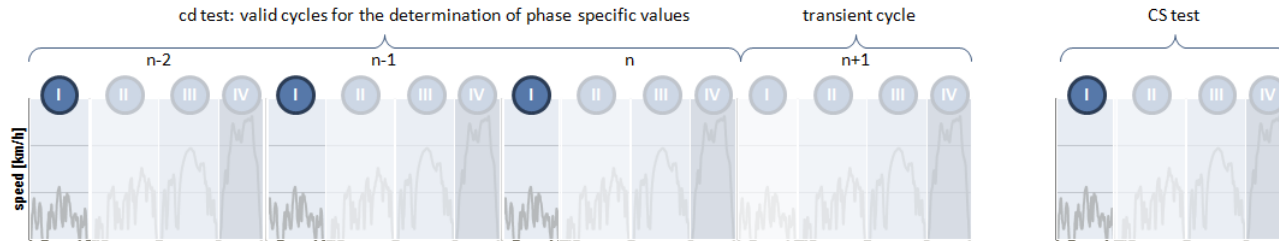
PHASE SPECIFIC CONSUMPTION FOR OVC-HEV.

JAPANESE APPROACH FOR PHASE SPECIFIC CONSUMPTIONS AND RANGES.



PHASE SPECIFIC CONSUMPTION FOR OVC-HEV.

CALCULATION OF ESTIMATED NUMBER OF DRIVEN CD PHASES.



virtual example:

		$C_{CD,Low} = \frac{\sum_{j=1}^n C_{CD,j,Low} \times D_{j,Low}}{\sum_{j=1}^n D_{j,Low}}$	$R_{CDa,Low} = \frac{C_{AC}}{C_{CD,Low}}$	$n_{Low} = \text{int} \left(\frac{R_{CDa,Low}}{D_{Low}} \right) + 1$
number of low phase j	$C_{CD,j,Low}$ [Wh/km]	$C_{CD,Low}$ [Wh/km]	$R_{CDa,Low}$ [km]	n_{Low}
1	110	103,3	96,8 (assumed $C_{AC} = 10$ kWh)	32
2	100			
3	100			

R: ► The number of estimated phases that could be driven consecutively is the basis for all following phase specific calculations.

R: ► The approach can only be applied to vehicles that are able to drive the whole first cycle in charge depleting because the transient cycle has to be excluded for the determination of the electric consumption to calculate the estimated electric range for the specific phase.

Q: ► How to handle with vehicles that are able to drive a transient cycle only?

Japanese answer

Proposed calculation formula doesn't take care of such a vehicle. Thank you for your feedback. Need to consider the alternative method for those vehicles.

ACEA

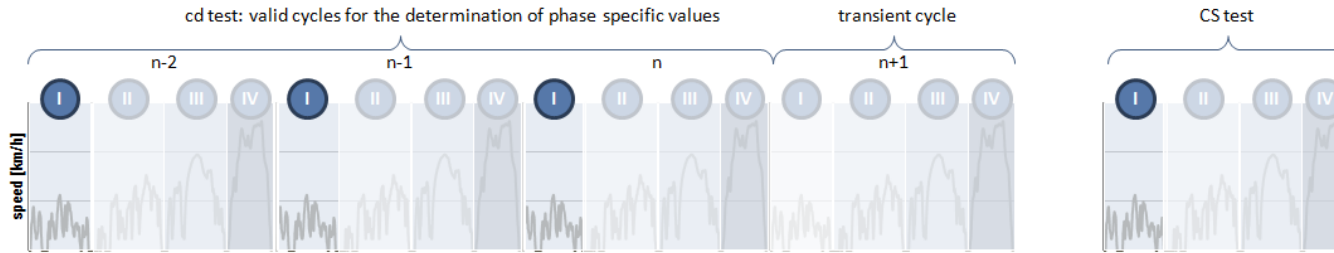
In that case a proposal could be to drive each phase separately. → higher test burden for such kind of vehicles

Q: ► How big is the impact of the "cold start" conditions if only one cycle can be used because the second one is a transient cycle?

Japanese answer:

It depends on the system, however, it has negative impact on performance value. It's OK for us to have an option to run the consecutive each phase test (L-L-L-L..., M-M-M-M...,) as an option.

PHASE SPECIFIC CONSUMPTION FOR OVC-HEV. CALCULATION OF ESTIMATED ELECTRIC RANGES.



virtual example:

$$CO_{2,CDavg,Low} = \frac{\left(\sum_{j=1}^n CO_{2,CD,j,Low}\right)}{n}$$

$$EAER_{Low} = \frac{(CO_{2,CS,Low} - CO_{2,CDavg,Low})}{CO_{2,CS,Low}} \cdot D_{Low} \cdot n_{Low}$$

$$R_{CDC,Low} = D_{Low} \cdot n_{Low}$$

number of low phase j	CO _{2,CD, j, Low} [g/km]	CO _{2,CDavg,Low} [g/km]	n _{Low}	CO _{2,CSavg,Low} [g/km]	EAER _{Low} [km]	R _{CDC,Low}
1	0	0	32	100	99	99
2	0					
3	0					

R: ► The CO_{2,CDavg,Low} will always be zero if there is no power-triggered engine start because the transient cycle is excluded. That means EAER_m equals R_{CDC,m}!

Japanese statement

Not available.

ACEA:

The calculation of RCDa is sufficient. The calculation of EAER and R_{CDC} has no additional value.

R: ► RCB-correction for each phase in charge sustaining is necessary! That is not required in the GTR now!

Japanese answer:

If no correction is necessary for whole cycle, no correction is required for each phase as basis. It's OK to allow manufacturer to develop each phase correction factor.

ACEA:

If the RCB correction is not required because the test is within the tolerance, the low and mid CO₂ will be lower and the high and extraHigh CO₂ will be higher than the value that would be determined by driving consecutive each phase cycles.

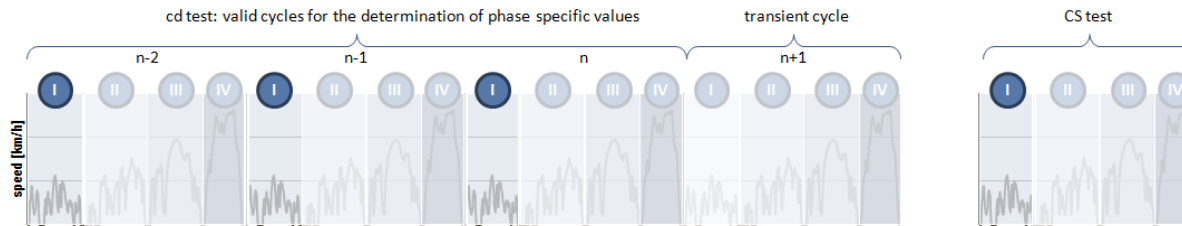
1.) First solution:

Each phase measurement .→ Disadvantage of higher test burden. → Is not recommended by the ACEA.

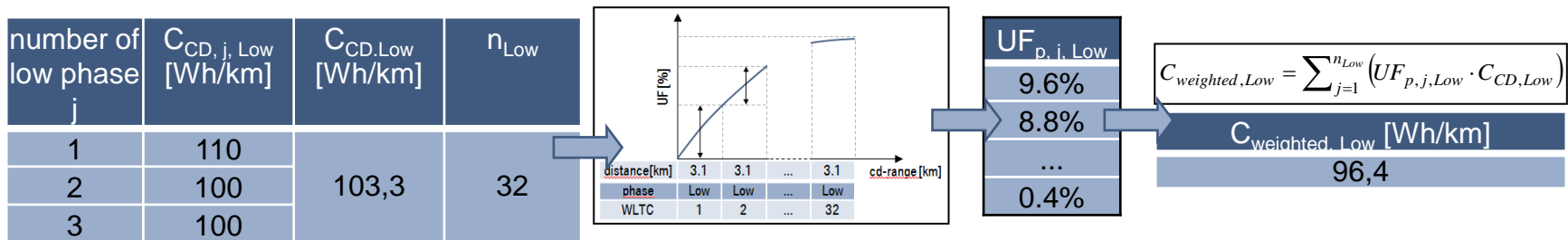
2.) Second solution:

An approach for each phase RCB-correction is to use the cycle energy. The energy demand over the whole cycle and the energy demand over each phase leads to an each phase percentage that can be used to calculate the each phase consumption by multiplication of each phase percentage and whole cycle consumption (nearly SOC neutral). BMW will work on a proposal for that issue.

PHASE SPECIFIC CONSUMPTION FOR OVC-HEV. CALCULATION OF ESTIMATED ELECTRIC CONSUMPTION.



virtual example:



ACEA

R: ► Is it valid to use the same UF curve for the weighting of each phase consumptions or do we need more criteria concerning the analysis of databases to determine a UF curve for the low, mid, high and exHigh – phase (e.g. a filter that distinguishes between urban and non-urban drive)!

Japanese answer:

A: We've made a decision to adopt regional UF for OVC-HEV calculation. Each region can adopt their own UF for also phase specific calculation. (JPN has only one UF and this UF is used for all kinds of calculation)

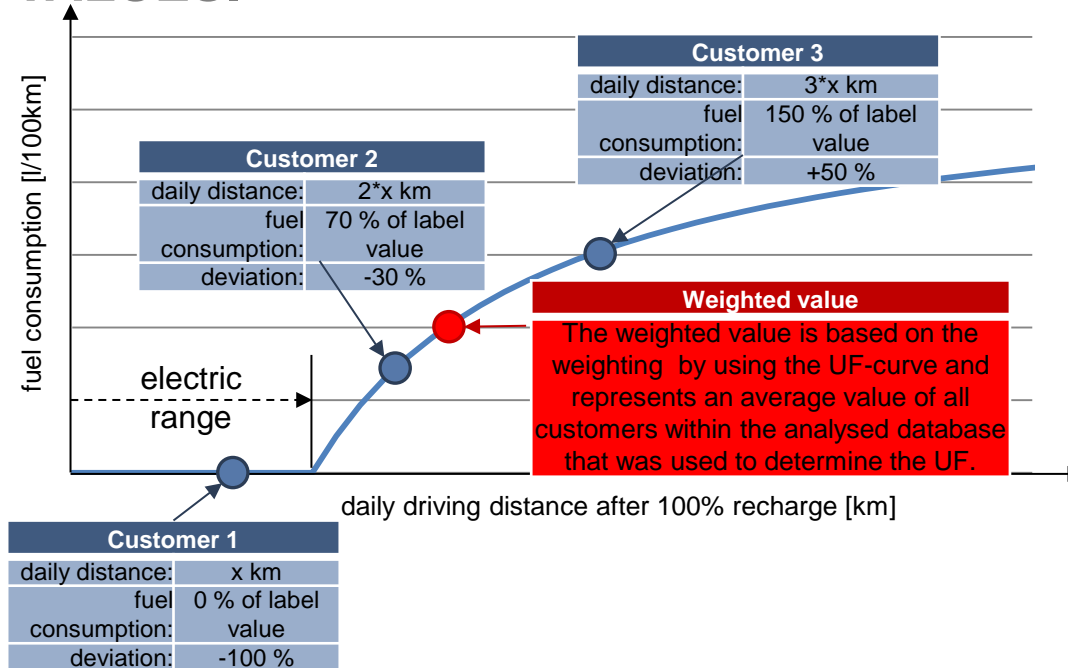
ACEA:

A: UF-weighted values are only made for the calculation of average fleet values. Each individual customer consumption hardly depends on the average daily driven distance.

→ ACEA proposes to delete the calculation of weighted each phase values.

PHASE SPECIFIC CONSUMPTION FOR OVC-HEV.

WEIGHTED VALUES ARE **UNSUITABLE** FOR CUSTOMER INFORMATION; FOR WHOLE CYCLE VALUES AS WELL AS FOR EACH PHASE VALUES.



ACEA

R: ► The figure shows the dependence from the daily driven distance of the customer concerning the fuel and electric consumption.

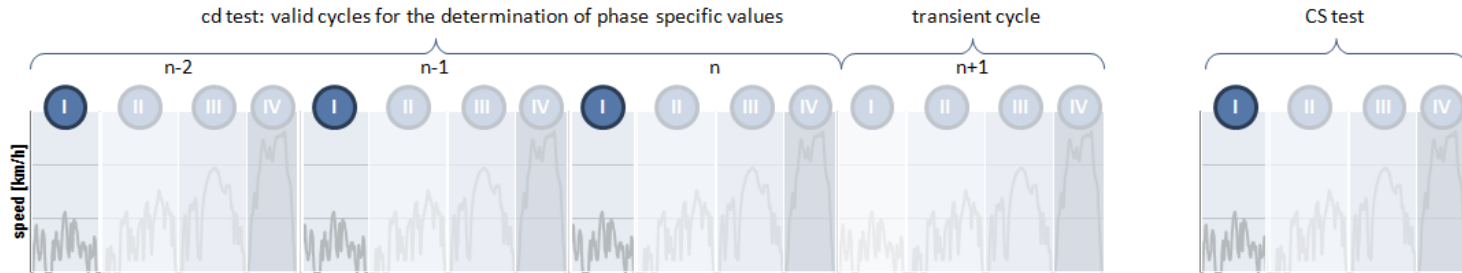
R: ► A weighted value is made to represent an average value for a fleet of vehicles, that can be used as a homologation value.

ACEA recommendation

R: ► Using of separated values for charge depleting and charge sustaining mode for customer information.

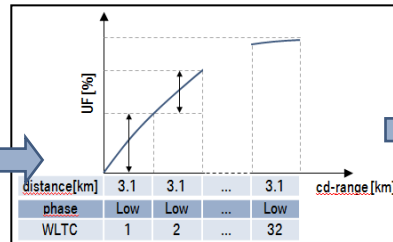
PHASE SPECIFIC CONSUMPTION FOR OVC-HEV.

CALCULATION OF ESTIMATED FUEL CONSUMPTION AND CO₂.



virtual example:

number of low phase j	CO _{2, CD, j} [g/km]	CO _{2, CD, Low} [g/km]	n _{Low}
1	0	0	32
2	0		
3	0		



UF _{p, i, Low}
9.6%
8.8%
...
0.4%

$$CO_{2, weighted, Low} = \sum_{j=1}^{n_{low}} (UF_{p, j, Low} \cdot CO_{2, CD, Low}) + (1 - \sum_{j=1}^{n_{low}} UF_{p, j, Low}) \cdot CO_{2, CS, Low}$$

CO _{2, weighted, Low} [g/km]
5 g/km

ACEA

R: ► The recommendation from ACEA is to delete the calculation for the weighted each phase fuel consumption (as well as for the weighted electric consumption) because weighted values are not suitable for customer information (see slide 5 and 6).

PHASE SPECIFIC CONSUMPTION FOR OVC-HEV. VALIDATION.

Q: ► How do the validation schemes/-results look like?

Japanese answer:

A : We don't think the validation test is necessary. If this formula is not acceptable, we request to run each phase test to obtain each phase specific value.

ACEA:

- In principle we agree to a lot of proposed issues concerning the each phase calculation (except for the issues we addressed on the slides before).

But ACEA also thinks

- that a validation with randomly chosen vehicles is helpful in order to make sure that approach works for all possible OVC-HEV concepts.
- that it is more expedient *to validate the approach now* instead of creating a giant test burden by testing each vehicle by driving consecutive each phase test.