

Step 1, determine real load and CO2 values

worst case (w/c) vehicle		best case (b/c) vehicle	
F0 wc IN	193.8	F0 bc IN	132.3
F1 wc IN(standard)	0.292	F1 bc IN(standard)	0.293
F2 wc IN(standard)	0.03015	F2 bc IN(standard)	0.02736
TML (kg)	1703	TML (kg)	1553
CO2 wc Low (kg/km)	169.5	CO2 bc Low (kg/km)	156.7
CO2 wc Mid (kg/km)	131.4	CO2 bc Mid (kg/km)	116.6
CO2 wc High (kg/km)	116.7	CO2 bc High (kg/km)	101.6
CO2 wc Ex-High (kg/km)	139.0	CO2 bc Ex-High (kg/km)	121.5
CO2 wc WLTC (kg/km)	134.6	CO2 bc WLTC (kg/km)	119.1

Additional information:

parameter	value
air density (kg/m ³)	1.225
air resistance coefficient (Cx)	0.3
rolling resistance coefficient (Crr)	0.01

Drafting group on the 'Combined approach'

Progress report for the DTP meeting 5 June 2013

wheels available	Product 1 (kg)	Product 2 (kg)	Product 3 (kg)
225DR16	C/8.4	C/8.4	C/8.4
225DR17	9.8	C/8.5	C/8.9
225R18	11.3	F/11.7	E/10.0

type used for RLID	measured RR	best case RLID (kg)
225DR16	8.4	C/8.4
225R18	11.7	F/11.7

I. Riemersma (T&E)

C. Lueglinger (BMW)

A. Feucht and M. Bergman (Audi)

W. Coleman (VW)

Y. Aoyama (Honda)

B. Mercier (PSA)

Regression			
20	400	63	
30	900	64	
40	1600	66	
50	2500	68	
60	3600	71	

Optional equipment, example	weight (kg)	RR (kg/50)	coFA (kg/F)	part into car
16" wheels base		8.4		
17" wheels rim 1	10	9.8	0.010	
17" wheels rim 2	5	9.8	0.020	x
18" wheels	10	11.3	0.044	
design package	5		0.011	x
glass roof	15			x
massage seat	60			
test	60		0.010	
Stow	150		0.065	
Delta wc-bc	150		0.066	
CO2 wc-bc	0		0.001	
Selected car	25	9.8	0.031	CO2-value: 124.5

CO2 (kg/km) / AVG of worst case	lower	upper	average
Class 1/A		6,4	5,9
Class 2/B	6,5	7,6	7,1
Class 3/C	7,7	8,9	8,4
Class 4/E	9,0	10,4	9,8
Class 5/F	10,5	11,9	11,3
Class 6/G	12,0		12,9

Phase	Time (s)	Dist. (km)	Time count	Dist. count
Low	589	3095	589	3095
Mid	433	4755	1022	7850
High	455	7162	1477	15012
Ex-High	323	8254	1800	23266
WLTC	1800	23266	1800	23266

Tasks for the drafting group

- Work out a detailed methodology to calculate/interpolate CO₂ for individual vehicles between a best-case and a worst-case vehicle
- Check the feasibility to interpolate vehicle parameters: mass, tyre rolling resistance (RR) and aerodynamic options
- Evaluate the accuracy of the methodology
- Transpose the methodology into the GTR (including relevant definitions)

Outline of the calculation method

CO₂ results from 2 road load determination tests (worst-case and best-case mass, rolling resistance and aerodynamics) yields:

ΔCO_2 , ΔF_0 , ΔF_2 , Δm ,

Calculate delta energy demand ΔE_{cycle} from target speed and road load coefficients :

$$\Delta E_{\text{cycle}} = \Delta E_{\text{kin}} + \Delta E_{F0} + \Delta E_{F2}$$

Diagram illustrating the components of ΔE_{cycle} :

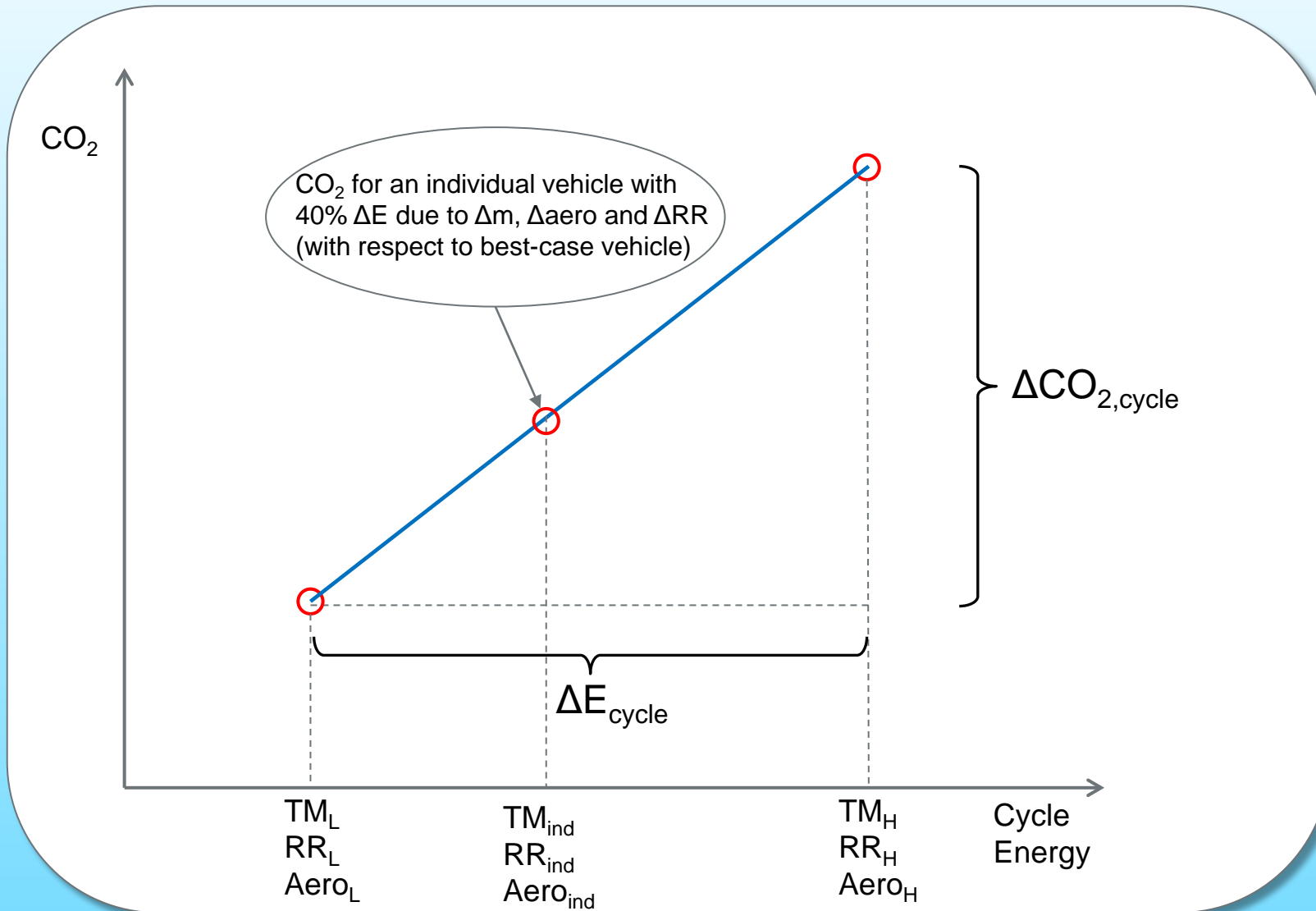
- ΔE_{kin} is derived from Δm (mass).
- ΔE_{F0} is derived from $\Delta RR, \Delta m$ (mass & RR).
- ΔE_{F2} is derived from $\Delta cd.A$ (aerodynamics).

For individual vehicles $\Delta E_{\text{cycle,ind}}$ is calculated based on Δm_{ind} , ΔRR_{ind} and $\Delta Cd.A_{\text{ind}}$

Assume for individual vehicles ΔCO_2 to be proportional to ΔE_{cycle}

⇒ engine efficiency is relatively constant for small ΔE variations (Willans lines)

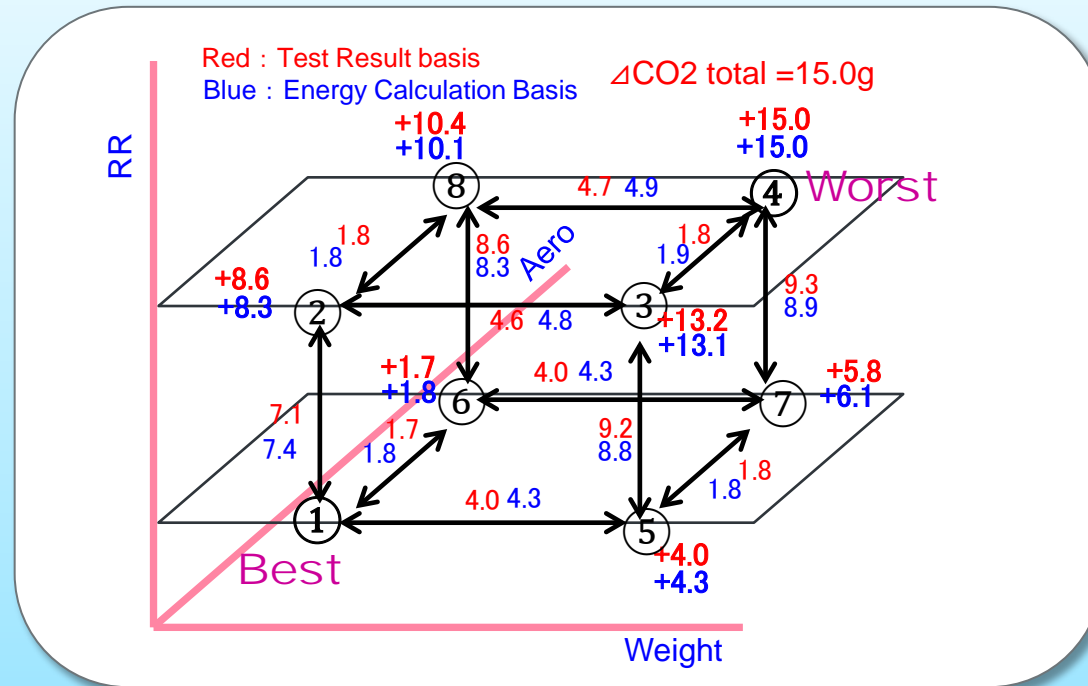
Interpolation method



Current state of play

- 5 tele/web meetings held since 27 February 2013
- Good progress due to efforts by all team members
- Main calculation/interpolation methodology is agreed
- Outputs:
 - Step by step description of the methodology (see document WLTP-DTP-LabProclCE-211)
 - Excel sheet with the calculation/interpolation procedure (see document WLTP-DTP-LabProclCE-212)
 - GTR text proposal: first draft just completed (not issued yet)
- Main open issues resolved
- Recent decision: interpolation is based on 2 measurements (worst-case and best-case vehicle)
- Work of the task force is near completion

Example: Simulation results by Audi



- ▶ Standard B-class vehicle with 4-cyl. gasoline engine and autom. transmission
- ▶ TM_L : 1568 kg; TM_H 1678 kg
- ▶ Difference in $\text{cd} \cdot A$: 0,0315 m^2
- ▶ Rolling Resistance min: 7,2 kg/t; max: 10,5 kg/t
- ▶ Range of 15 g/km CO_2 between worst- and best case vehicle

Example: Simulation results by Audi

Whole WLTC

					ENERGY [kJ]	CO ₂ [g/km] Simulation	CO ₂ [g/km] Interpolation by energy	ΔCO ₂
	WEIGHT	Δaero (m)	RR (kg/t)	Total	Total	Total	Total	
1	BASE	1568	0	7.2	10807	155.4	155.4	0.0
2	1+RR	1568	0	10.5	11700	163.9	163.7	0.2
3	2+Weight	1678	0	10.5	12221	168.6	168.5	0.1
4	3+Aero	1678	0.0315	10.5	12420	170.4	170.4	0.0
5	1+Weight	1678	0	7.2	11269	159.4	159.7	-0.3
6	1+Aero	1568	0.0315	7.2	11004	157.1	157.2	-0.1
7	5+Aero	1678	0.0315	7.2	11465	161.1	161.5	-0.4
8	2+Aero	1568	0.0315	10.5	11900	165.7	165.5	0.2
	ind	1604	0.0079	8.2	11283	159.7	159.8	-0.1

- ▶ Range of 15 g/km CO₂ between worst- and best case vehicle
- ▶ Maximum deviation between the simulation and the interpolated values is less than 0.5 g/km (standard gasoline engine).
- ▶ Deviations are lower for individual vehicles.

Final steps

- Discuss the draft GTR text on the combined approach
- Address remaining details:
 - Vehicle family parameters
 - Definition of unladen mass
 - Allowable CO₂ interpolation range
 - Cycle downscaling
- Finish an agreed GTR text proposal before the summer