Appendix to
WLTP-18-19e

Japan contributions on Annex 4 TF

19th April, 2017

WLTP IWG

Japan Proposal on Wind Tunnel Method

Background of Proposal

- While reviewing the road load measurement method, Japan have found the potential serious problems on **the wind tunnel method**.

- Concern in Japan is on "**Aerodynamic drag* measurement**."

*) For wind tunnel method, the aero dynamic drag and the rolling resistance are measured separately. The sum of 2 values will be the road load value of vehicle.

*Vehicle road load value = **Aerodynamic drag** + Rolling Resistance*

← Wind Tunnel:
Used to measure
Aerodynamic drag

Flat Belt or CH-DY:→
Used to measure
Rolling Resistance

Concerns on Aerodynamic drag Measurement

- **There is no wind tunnel test method written in Annex 4.**
  - "3.2 Wind tunnel criteria" only indicates; specification of laboratory and test equipment.
  - "6.4. Wind tunnel procedure" only indicates;
    - "Wind tunnel criteria" & setting of measuring equipment
    - Test vehicle position (how shall it be placed against wind)

- **This leads many interpretations for "reference speed" to measure aerodynamic drag using wind tunnel;**
  - At only one wind speed?
  - At several wind speeds?
  - At every wind speeds as same as coast down method? (this is ridiculous!!)

*) "3.2.1. Wind velocity" have speed indication. But this is specification of laboratory…

3.2.	Wind tunnel criteria
3.2.1.	Wind velocity
	The wind velocity during a measurement shall remain within ±2 km/h at the centre of the test section. The possible wind velocity shall be at least 140 km/h.

Revision Proposal to Current Annex 4 Text

To clarify the Wind Tunnel Method…

3.3. General requirements for wind tunnel method

3.3.1. Measurement of aerodynamic drag shall be performed according to 6.1.2.2 of ISO 10521-1 or 2.3.1.2. of JIS D1012 2005*.

3.3.2. The road load value measured by wind tunnel method is recommended to calculate using the results of **2 or more wind speeds**** and 0 kph. The aerodynamic drag at 0 kph shall be equal to 0.
In the case that the vehicle has movable aerodynamic body parts, paragraph 4.2.1.5. of this annex shall apply.

(*) These standards includes measurement instruction of aerodynamic drag.
(**) See data on following pages

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6.2.3. Measurement with the wind tunnel method according to paragraphs 3.3. and 6.3. to 6.7. inclusive of this annex shall be performed on the same three vehicles as selected in paragraph 6.2.1. of this annex and in the same conditions, and the resulting road load coefficients, f0, f1 and f2, shall be determined. The certification tests shall be performed with the procedure used at wind tunnel approval.

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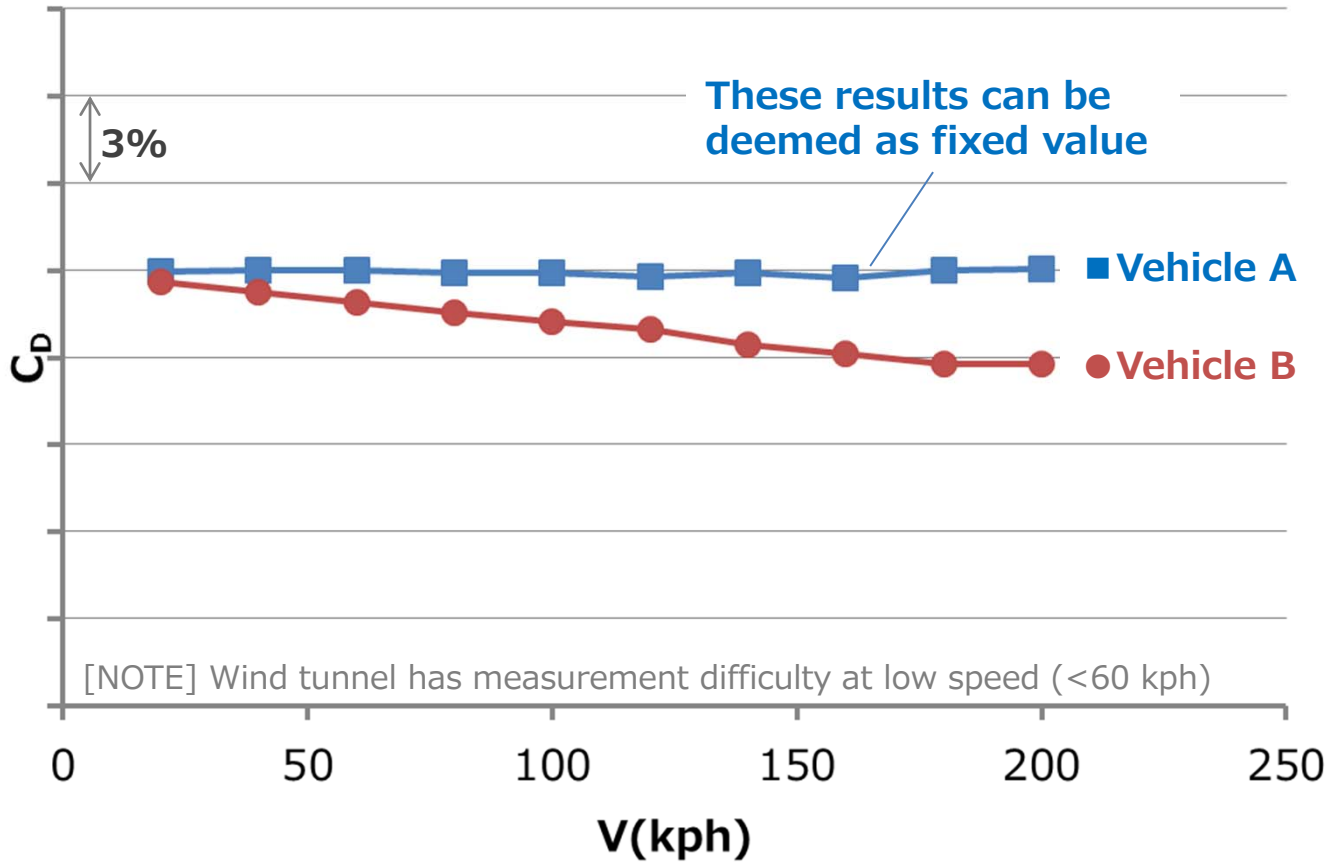
6.4.2. The vehicle shall be in the condition described in paragraph 6.3. of this annex.
…
Aerodynamic drag shall be measured according to 3.3 of this Annex.
Aerodynamic drag shall be measured for at least for 60 seconds …

Purpose of Recommendation on Measuring Aerodynamic Drag at 2 or More Wind Speeds

Aerodynamic drag of certain vehicles using Wind Tunnel

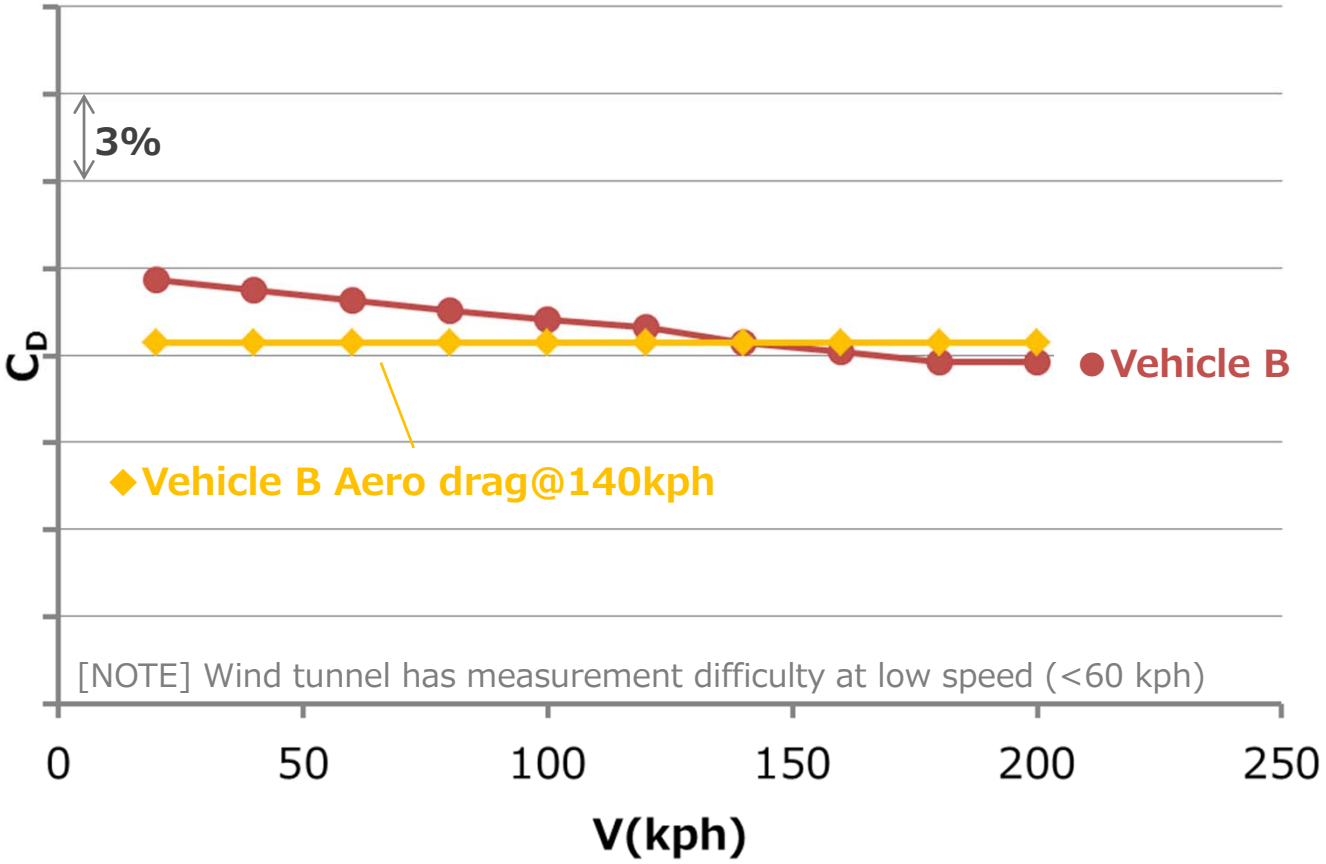
- While testing certain vehicles, existence of 2 groups of vehicles on aerodynamics drags are learned from results.



Vehicle without movable aero parts might also have aerodynamic drag depending on “speed”

Graph of Vehicle B if Aero-drag Measured Only @ 140kph

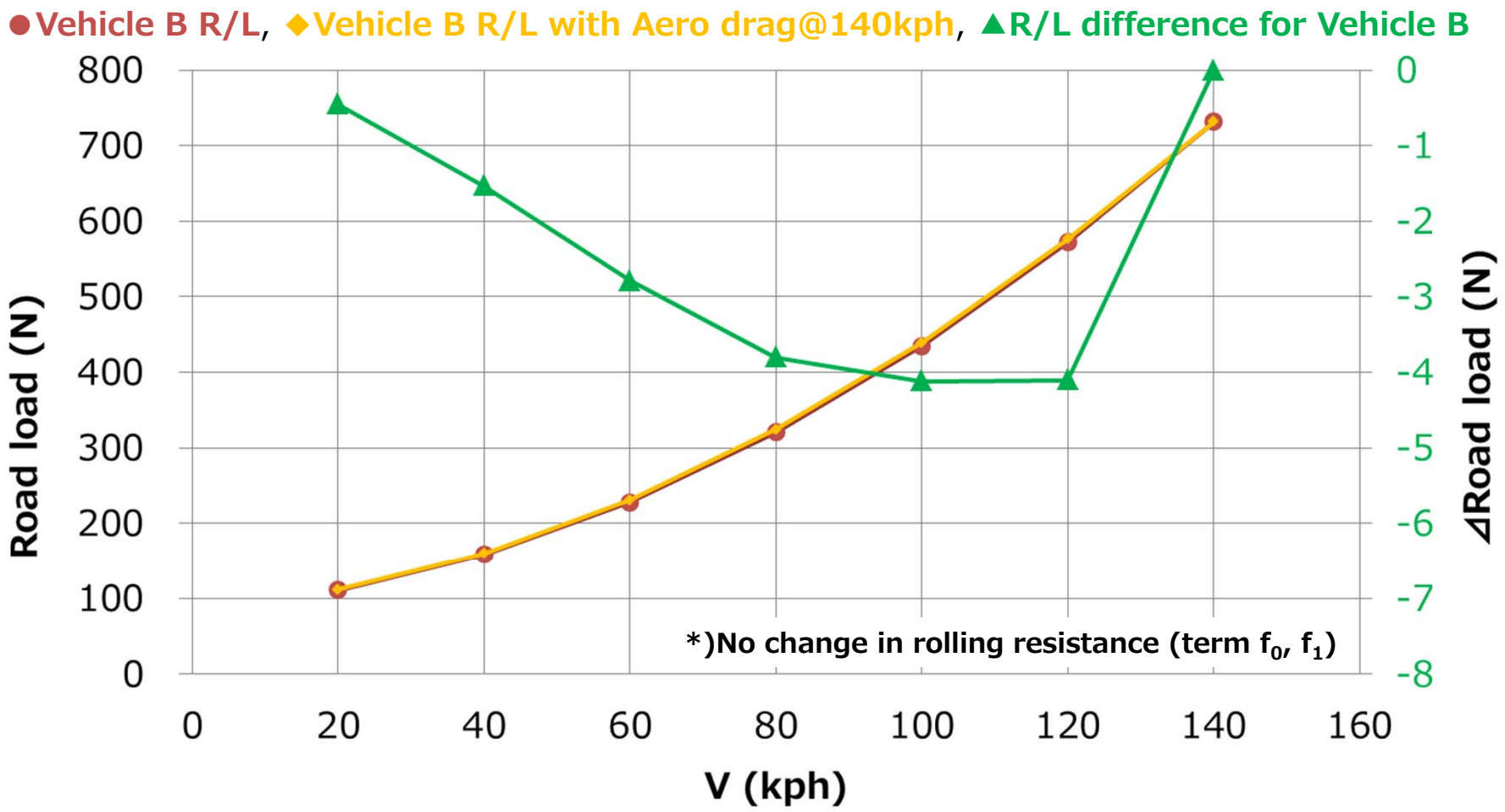
- The drag difference depending on speed assumed to be caused by many reasons. However, those are too complex to separate and correct at calculation.



For vehicle B, <u>MAX 3%</u> difference cause at low speed.

Effect on Road Load Values of Vehicle B

[For Vehicle B] Road load: **Max ⊿4N** / Cycle energy: **⊿0.5%** (@4 Phase)



[NOTE] "3 %/ 4N" is the data only from <u>a certain vehicle</u> which was tested at several points. Which means, other vehicles **<u>might have more differences or less</u>**.
No one knows until the vehicle is tested at several points.

Question: Can this situation be ignored or be permitted?

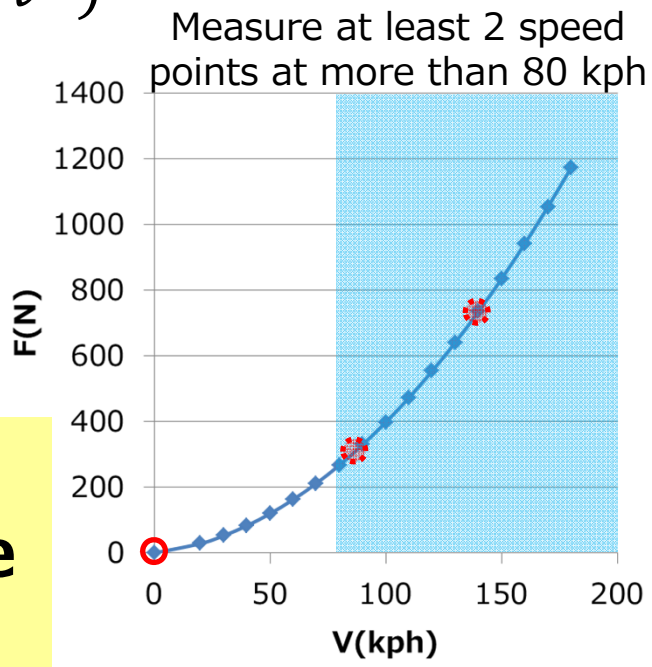
Why recommend 2 or more Speed Points, not all?

- The wind tunnel test equipment tend to have low accuracy on measuring aerodynamic drag at low speed. (mostly less than 80 kph. Ref. 6.1.2.2 of ISO 10521-1 or 2.3.1.2. of JIS D1012_2005)

- Road Load equation consists of ternary quadratic equation. With more than 3 road load results (including 0 kph), road load curve can be determined.

$$F_c = f_0 + (f_1 \times v) + (f_2 \times v^2)$$

- Avoid test burden.



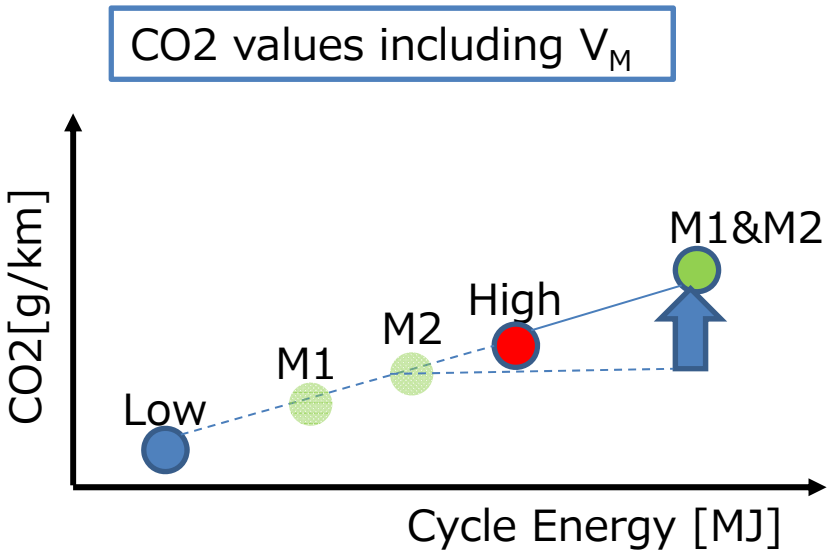
Considering accuracy and test burden, “measurement at 2 or more wind speeds” is recommended.

Annex 4 TF
Japan Proposal on Other topics

RRC determination for tyre categories

Problem

When we have V_H of interpolation family with RRC less than class value, CO2 values of V_M will be worse than V_H.



Vehicle	Low	M1	M2	High
Test mass	1200	1200	1200	1200
RRC	6.6	**7.1**	**7.1**	7.0
F1[N/kph]	0.2	0.5	0.5	0.4
Cycle En[MJ]	4.0	**5.2**	**5.2**	5.0
CO2[g/km]	100	**130**	**130**	120

Solution

Add an option to use measured RRC value also for V_M.

Table A4/2 in GTR15

Class	*C1 range*
1	RRC ≤ 6.5
2	6.5 < RRC ≤ 7.7
3	7.7 < RRC ≤ 9.0
4	9.0 < RRC ≤ 10.5
5	10.5 < RRC ≤ 12.0
6	RRC > 12.0
Class	*C1 class value*
1	RRC = 5.9
2	RRC = 7.1

Thank you for your attention.