

World Light Duty Test Procedure

For Class III Vehicles

1. Analysis of Velocity Margin
2. Proposal on Discrete Velocity Caps



Presentation from India
15th Jan, 16th DHC Meeting
Geneva, Switzerland

Background – 15th DHC

- For vehicles with $V_{max} > 120$ km/h, it was decided to have velocity capping on Ex-High Phase (if applicable in that CP).
- The velocity capping would be based on margin as a % on max speed of the vehicle
- A proposal of 10% was discussed in the last DHC meeting
- This presentation summarizes an analysis of this margin considering two vehicles A and B

Vehicle Information

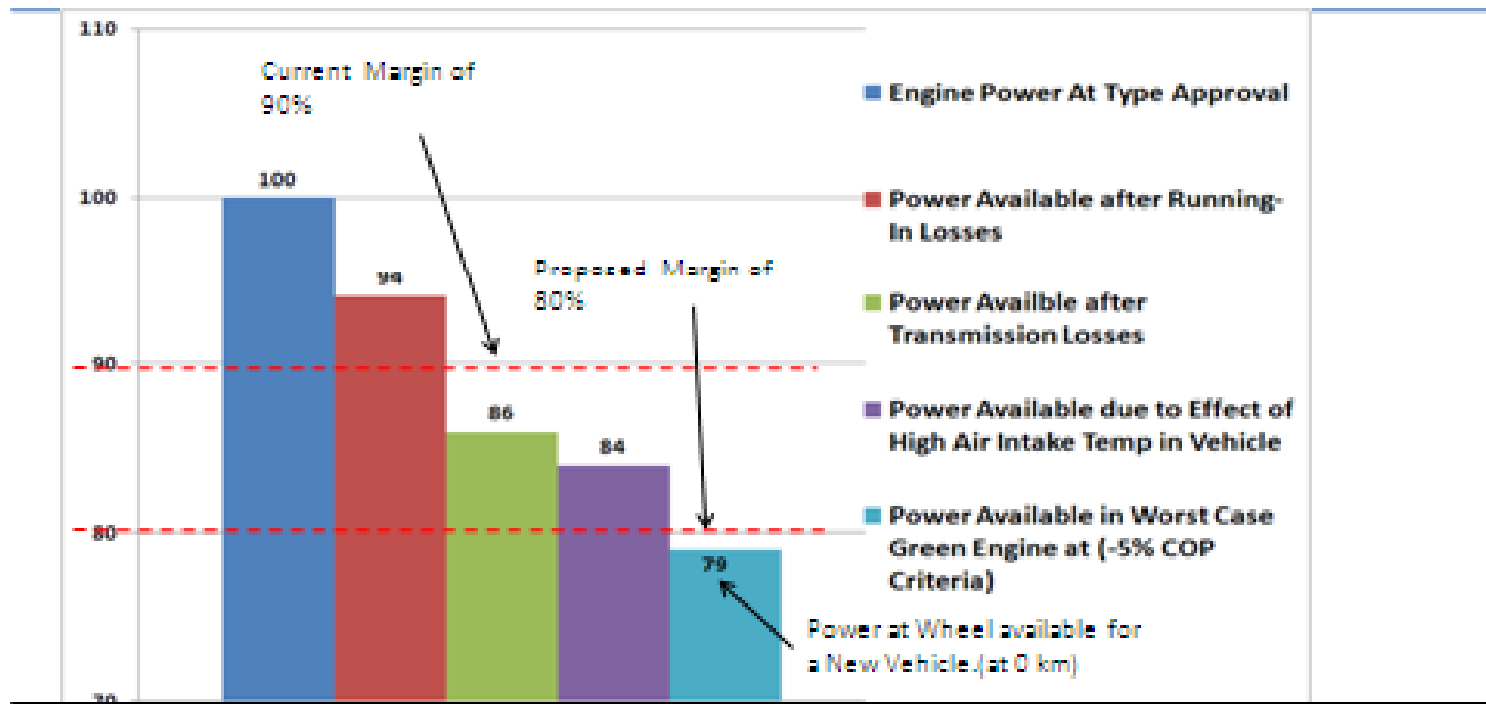
Vehicle	Engine CC	Power, kW	Kerb Wt. kg	PMR kw/ ton	Max Speed km/h	Vcap @10%	Vcap @15%
A	796	34.5	705	49.0	135	121.5	114.8
B	998	49.2	860	55.6	145	130.5	123.3

The following were analyzed for 10% and 15% margins from Max speed in terms of:

- Cycle Power Demand vs. Available Vehicle Power
- Fuel Economy
- RPM-Load Scatter

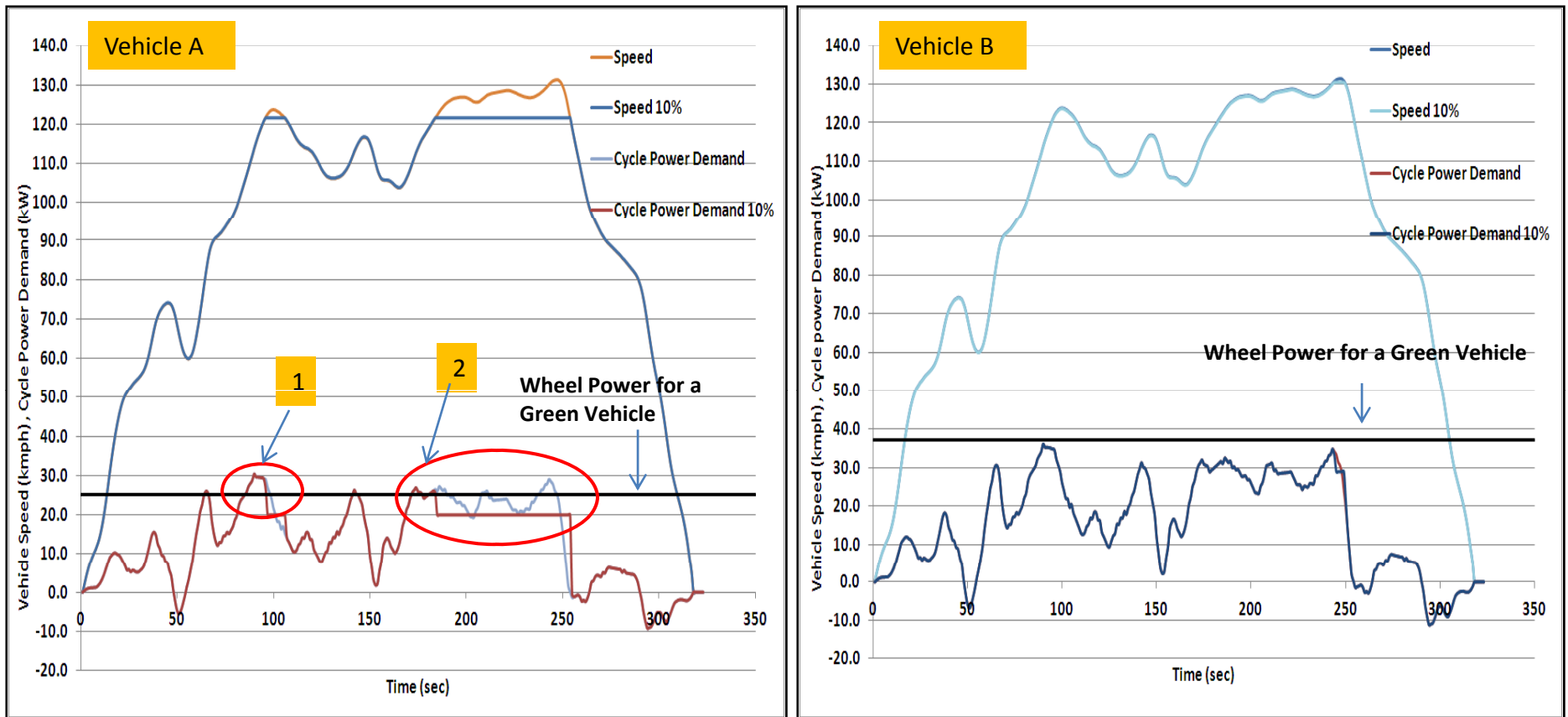
Engine Power vs Wheel Power

Safety Margin on Full Load Power Curve



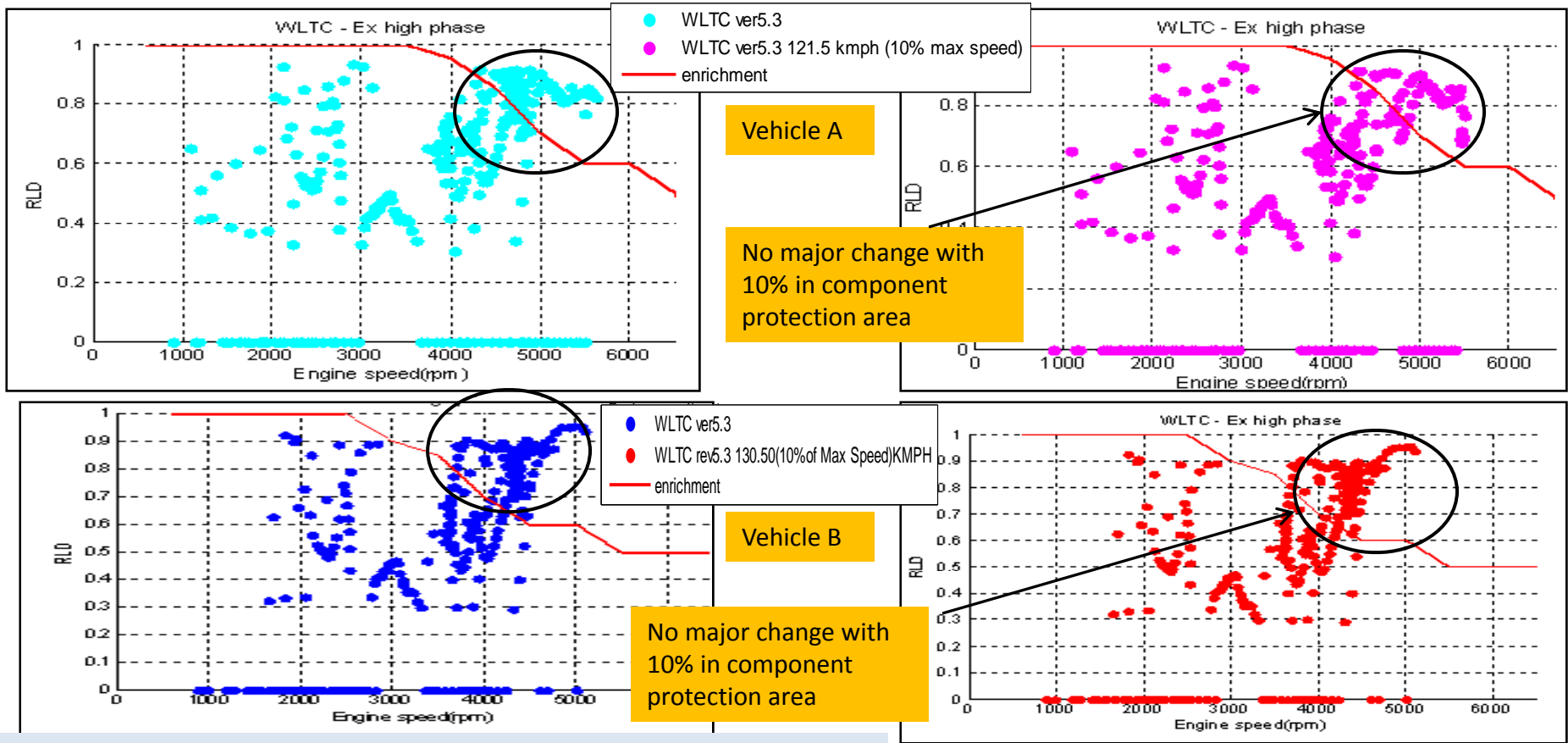
- Source : WLTP –DHC-14-05
- India had presented in 14th DHC Meeting that only 80% of the Engine Power is Available at Wheel for a Green vehicle.

10 % Margin : Cycle Power Demand Analysis



- For Vehicle A , a margin of 10% is not adequate as cycle power demand is higher than available power of the vehicle. Also verified from RPM load scatter / FE data in the next slide. (Pt 1&2)
- For Vehicle B , at a margin of 10% , the available power of the vehicle just meets the cycle power demand.

10% Analysis : Engine Load & FE Analysis

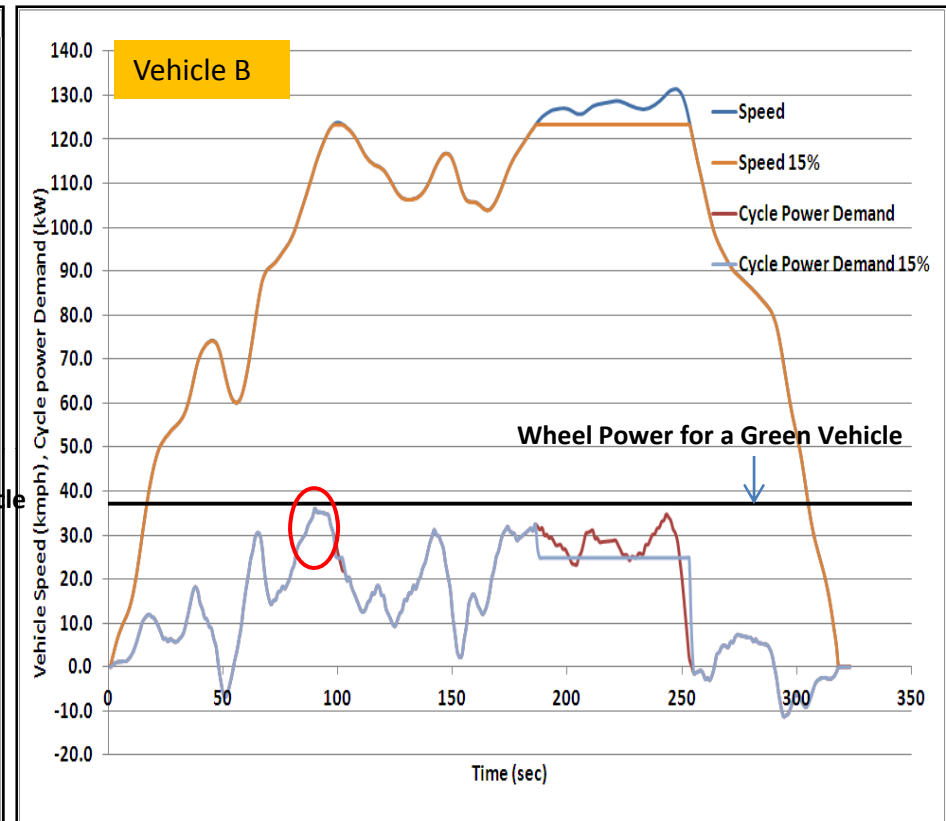
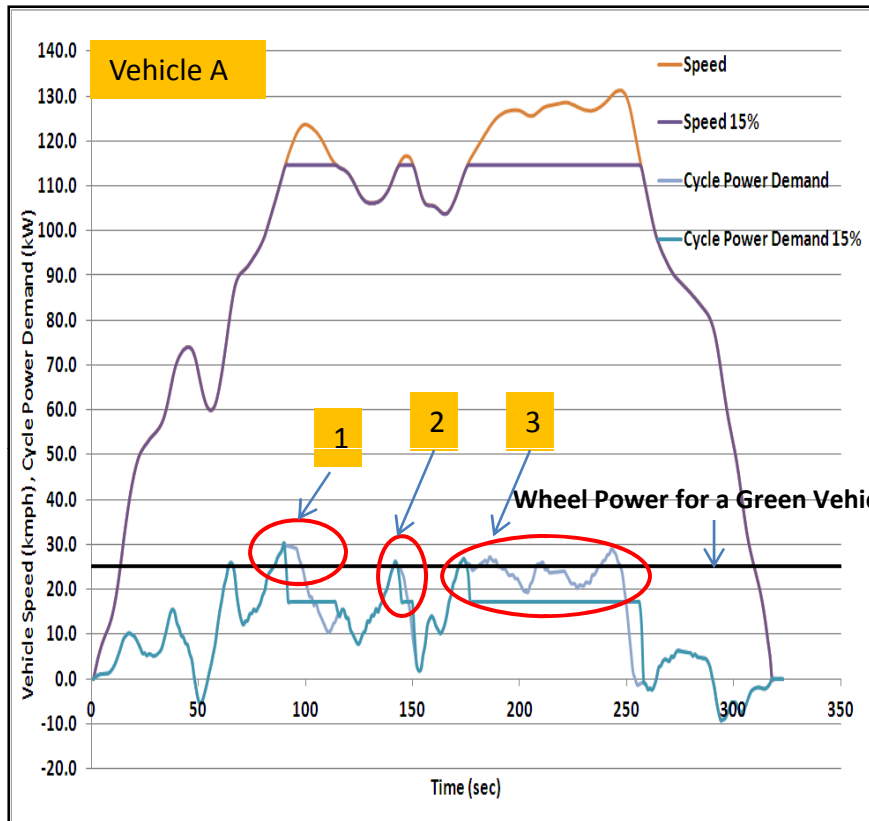


- Vehicle A : no major change observed in the Load-RPM scatter diagram of Component Protection Area .
- For Vehicle B, 10% margin speed (130.5km/h) is almost same as Ex-H Peak Speed of 131.7 km/h. Hence no change seen in Component Protection area.

For both vehicles A and B, no change in FE observed with 10 % capping.

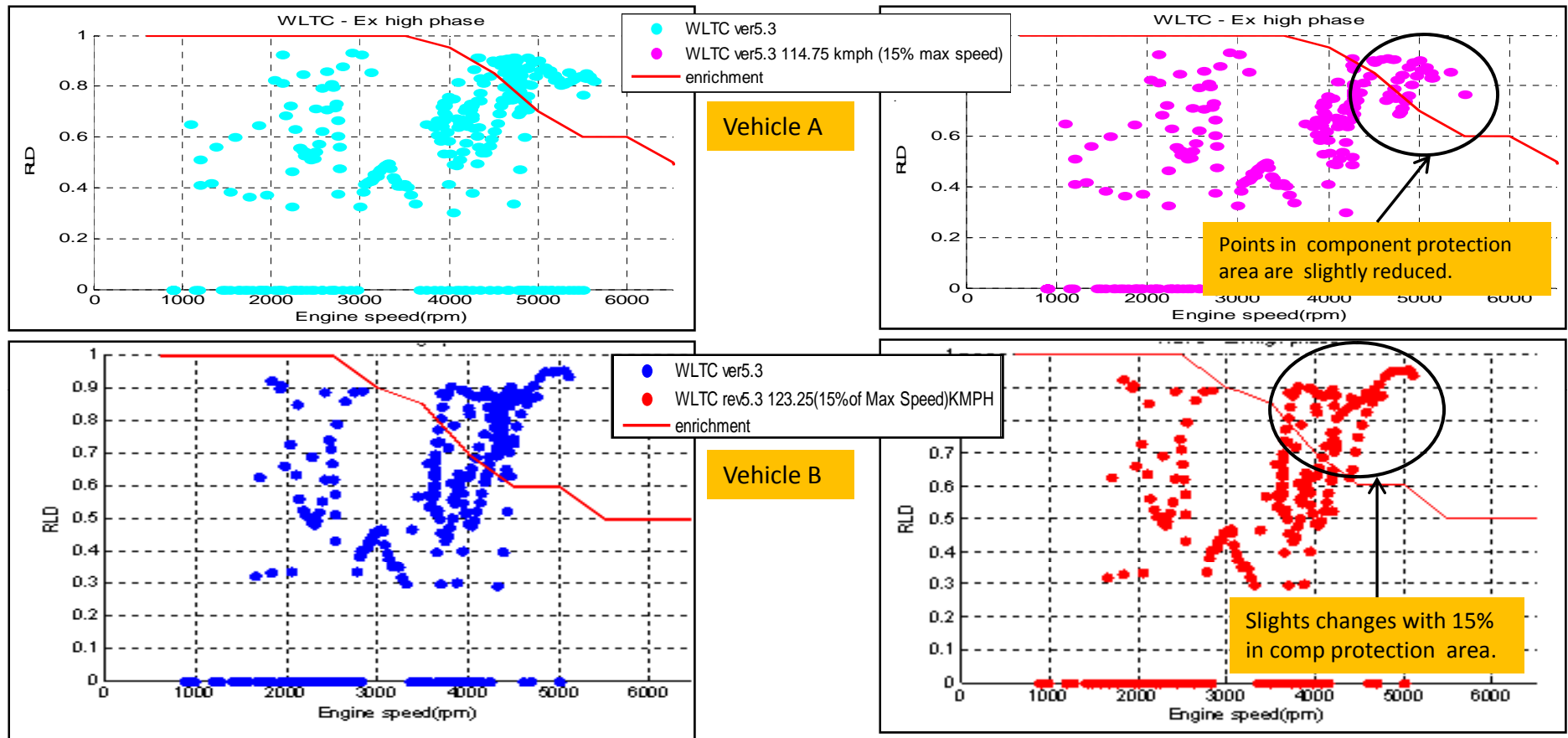
Vehicle	Speed (WLTC Cycle V 5.3) (kmph)	FE (KMPL)	% Change V5.3 with diff Max Speeds
A	Declared Max Speed (135 kmph)	18.51	Base
	Max Speed 121.5 (10%)	18.50	-0.05%
B	Declared Max Speed (145 kmph)	16.61	Base
	Max Speed 130.50 (10%)	16.61	0.000%

15% Margin : Cycle Power Demand Analysis



- At 15% margin, for Vehicle A, the available power just meets the cycle power demand.
- At 15% margin, for Vehicle B, the cycle power demand is conveniently met by the available engine power.

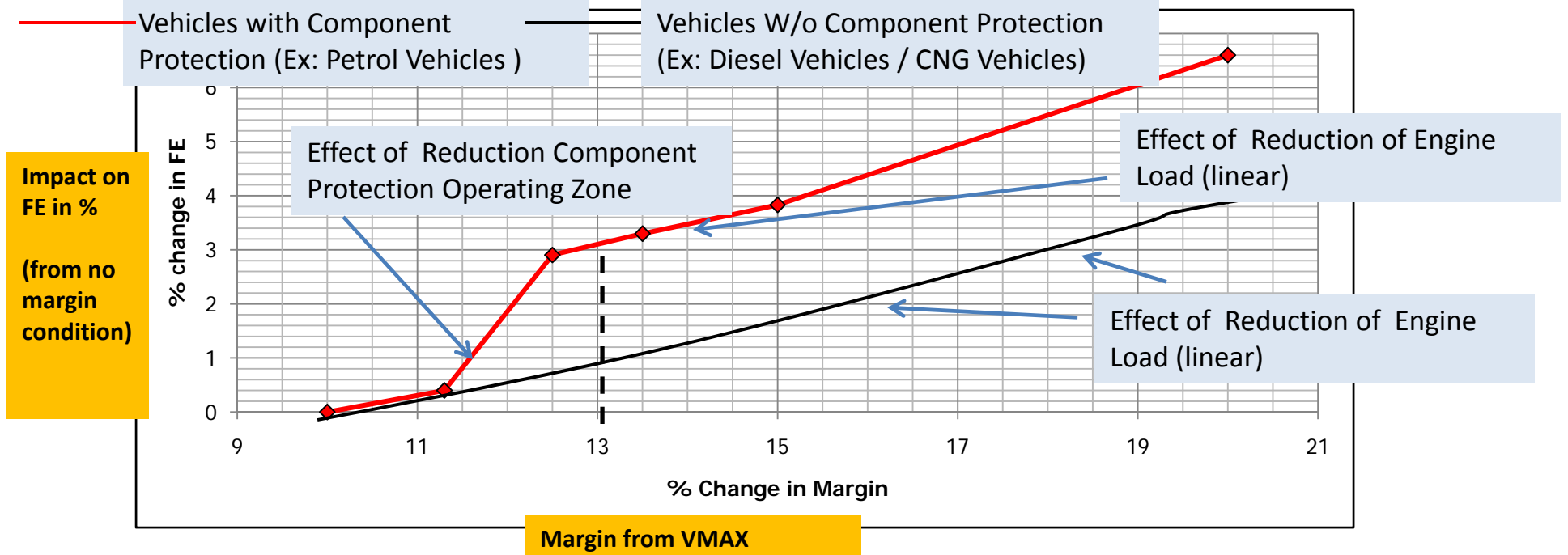
15% Margin : Engine Load & FE Analysis



- For Vehicle A , at 15 % margin, reduction in scatter points observed in the Component Protection Area of Load-RPM scatter diagram .
- For Vehicle B, at 15% margin, points are reduced in the component protection area.
- Slight FE improvement observed in case of both the vehicles. (Please refer to note in the next slide)

Vehicle	Speed (WLTC Cycle V 5.3) (kmph)	FE (KMPL)	% Change V5.3 with diff Max Speeds
A	Declared Max Speed (135 kmph)	18.51	Base
	Max Speed 114.75 (15%)	19.22	3.83 %
B	Declared Max Speed (135 kmph)	16.61	Base
	Max Speed 123.25 (15%)	16.84	+1.38 %

A Note : Effect on FE Vs Max Velocity Margin%



- As shown above the component Protection zone has a major influence on Gasoline Applications. With the increase in margins, the points in engine protection area reduces which show increase in FE.
- Outside the component protection Zone the effect is almost linear.
- Diesel vehicles / CNG Applications or Vehicles not having any component protection will not show this trend and FE increase will be marginal. 9

Summary

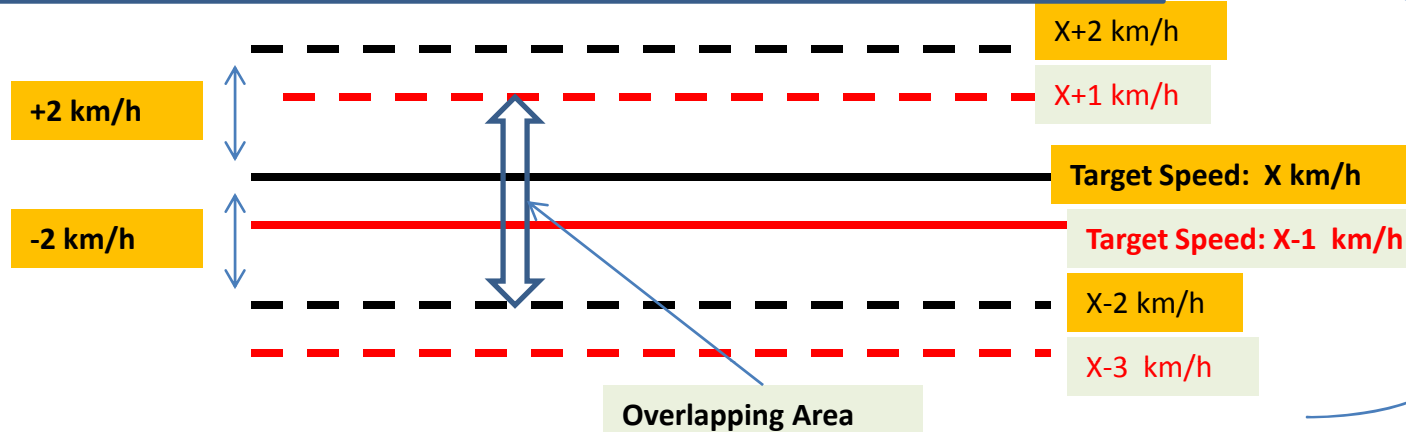
- Margin of 10% on Max Vehicle Speed is not suitable for Vehicles having max speed between 120 to 145 km/h as seen by engine operating points.
- Based on the analysis at least 15% margin on speed will be appropriate considering Cycle Power Demand and Component Protection.

2. Proposal on Discrete Velocity Caps

- Determining Velocity Caps for vehicles having Max Speeds between 120 and 145km/h will generate at least 25 different test patterns.
- Speed tolerance of at least +/- 2km/h, will cause overlapping of these test patterns within this tolerance.
- It is suggested to have discrete Velocity Caps, to minimize effort in calculation and implementation as shown in the next slide.

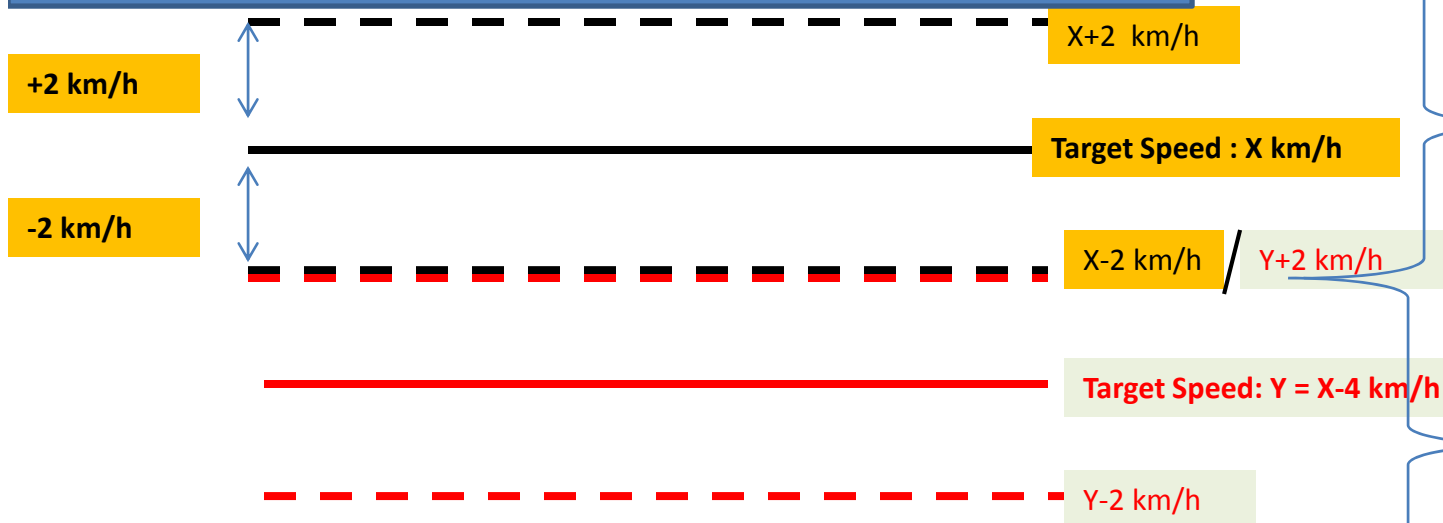
Discrete Velocity Caps-Concept

Current Scenario with Variable Max Speed



Two Vehicles with difference of 1km/h in their target speeds will be driven on the same cycle due to Speed Tolerance of ± 2 km/h.

Proposal with Discrete Bands



All vehicles whose target speed falls within the speed tolerance should be driven on the same target speed X .

Similar approach for the next step, where $X-Y = 4$ km/h

Proposal-Discrete Velocity Caps

Group	Vehicle Max Speed A	Max Speed with 15% Margin B = 0.85*A	Target Speed C	Actual Margin wrt to Target Speed D = (1-C/A)%
1	121	102.9	104.6	13.6%
	122	103.7		14.3%
	123	104.6		15.0%
	124	105.4		15.7%
	125	106.3		16.4%
2	126	107.1	108.8	13.7%
	127	108.0		14.3%
	128	108.8		15.0%
	129	109.7		15.7%
	130	110.5		16.3%
3	131	111.4	113.1	13.7%
	132	112.2		14.4%
	133	113.1		15.0%
	134	113.9		15.6%
	135	114.8		16.3%
4	136	115.6	117.3	13.8%
	137	116.5		14.4%
	138	117.3		15.0%
	139	118.2		15.6%
	140	119.0		16.2%
5	141	119.9	121.6	13.8%
	142	120.7		14.4%
	143	121.6		15.0%
	144	122.4		15.6%
	145	123.3		16.2%

Based on the previous reasoning, the 5 distinct groups can be formed.

The target speed for various groups is as shown.

The actual margin of the speed point wrt to target speed is also shown.

Impact on FE (Inter Group Variation)

Group	Vehicle Max Speed A	Max Speed with 15% Margin B = 0.85*A	FE km/l
3	131	111.4	17.54
	132	112.2	
	133	113.1	
	134	113.9	
	135	114.8	
4	136	115.6	17.24
	137	116.5	
	138	117.3	
	139	118.2	
	140	119.0	
5	141	119.9	16.92
	142	120.7	
	143	121.6	
	144	122.4	
	145	123.3	

1.7% (between Group 3 and Group 4)

1.9% (between Group 4 and Group 5)

- One Vehicle was tested with mean speed of Group 3 , Group 4 and Group 5 to check the inter-band variation.
- Percentage Difference in FE between mean speed points of 3 consecutive group was found to be within 2%

Impact on FE (Intra Group Variation)

Vehicle A

Group	Vehicle Max Speed A	Max Speed with 15% Margin B = $0.85 * A$	FE km/l
3	131	117.9	18.60
	132	118.8	
	133	119.7	
	134	120.6	
	135	121.5	

0.5%

Vehicle B

Group	Vehicle Max Speed A	Max Speed with 15% Margin B = $0.85 * A$	FE km/l
5	141	119.9	17.05
	142	120.7	16.92
	143	121.6	
	144	122.4	
	145	123.3	

0.8%

- Two Vehicles were checked in Group 5 for variation in FE within the speed points of a same group.
- Difference between extreme speed point and target speed of each group is found to be less than 1%.

Summary

- The proposal of having discrete velocity caps would reduce the effort in calculation and implementation for different cycles for different speeds.
- FE variation , at speed points within a group was found to be negligible .
- FE variation , at mean speed points of two neighboring groups was found to be within 2%.

THANK YOU