

Downscaling Proposal

India Short validation results
India Proposal



India Presentation
5th June, 18th DHC Meeting,
Geneva.

Background

During the discussions in WLTP DHC Telecon on 16th May, 2013:

1. India confirmed Acceptability of Downscaling Principal with the consideration for:

- a) taking care of vehicles which are not able to trace the cycle, and
- b) taking care of vehicles which show very high P_WOT operation

2. Based on above, a short validation was proposed by WLTP-DHC.

Action plan formulated:

- Validation of Downscaling Proposal and
- Possible solutions to alleviate the concerns raised by India

DownScaling Proposal- Validation Summary

Sno	Class	Vehicle	Fuel type	Steven Proposal	Test Results Remarks				
				Downscaling %	Traceability	Traceability Error Duration	% Time where Req'd power > 95% avail Power (EXH Phase)	Vmax, kmph	Rated RPM
								Cycle V Max	Cycle Max RPM
1	Class I	A	Diesel	5.6%	○	5 sec	4.2%		
2		B	Diesel	10.5%	○				
3		C	Diesel	12.3%	○	0 sec			
4	Class II	D	Diesel	3.1%	○		3%		
5		E	Gasoline	23%	○	0 sec	40.0%		
6	Class III	F	Gasoline	0%	X	14 sec	11.8%		
7		G	CNG	7.9%	X	45 sec	23.8%		
8		H	Gasoline	0%	○	4 sec	2%		

Traceability

X

Not Ok

○

OK

Class I : Vehicle Validation Results

Observations on the WLTC Cycle Down scaling software tool

1. Class I :

- a) Once Class I cycle is selected, %Downscaling drop box selection becomes inactive in software tool provided.
- b) Some times the tool doesn't work if you would like to work for the same data file.
- c) Class-1 cycle generated with the coast down values show the truncation in the cycle rather than shifting the cycle with the down scaling factor as it happens correctly for class-3.
- d) For the same vehicle when the down scaling is applied with the road coast down coefficients a & b, but , if we modify the polynomial interms of $F = a + bV + cV^2$ the tool doesn't give the down scaling at all. Theoretically, it shall provide the same down scaling.

Example: Vehicle A:

Vehicle Road load coeff by coast down on road	Polynomial	Down scaling factor calculated
$f_0 = 121.74, f_2 = 0.11$	$F = f_0 + f_2 * V^2$	12.3 %
$f_0 = 138.6, f_1 = 2.28, f_2 = 0.027$	$F = f_0 + f_1 * V + f_2 * V^2$	0%

Example: Down scaling Factor Calculated for Class-1 Vehicle A

Microsoft Access - [Calculate gearshifts for a single vehicle]

File Edit View Insert Format Records Tools Window Help

Task

Type a question for help

Tahoma 8

The additional safety margin is fully applied at idling speed and then linearly reduced to 0 at rated speed

The power curve builds the basis of the gear use calculation

n_{min_drive} is the minimum engine speed during drive phases in gears > 2.
minimum GTR draft 1494 min-1
minimum absolut 1437.5 min-1

class 1: $pmr_kerb \leq 22$,
class 2: $22 < pmr_kerb \leq 34$,
class 3: $pmr_kerb > 34$

determine additional safety margin
0.0%

choose power curve
Class 1 Vehicle A

choose vehicle_no
5

determine n_{min_drive}
1494

choose cycle
class 1, version 2

choose vehicle speed cap
0.0%

modify test mass

cycle part

time in s

You have to insert a case name and then press the "check calculation settings" button in order to activate the "calculate gearshifts" button

case description
Class 1 Veh A

Check calc settings Calculate gearshifts Check for calculation

Check results Check average n_{norm} Export results to Excel

Check for $P_{max} < P_{res} 1$ Check for $P_{max} < P_{res} 2$ Check wot percentage

check v for $P_{res} = P_{rated}$ Check P_{res} Check $n_{norm} > 120\%$

Check for high revs

Microsoft Office Access

This vehicle would require 5.6 per cent downscaling!

OK

Record: 1 of 1

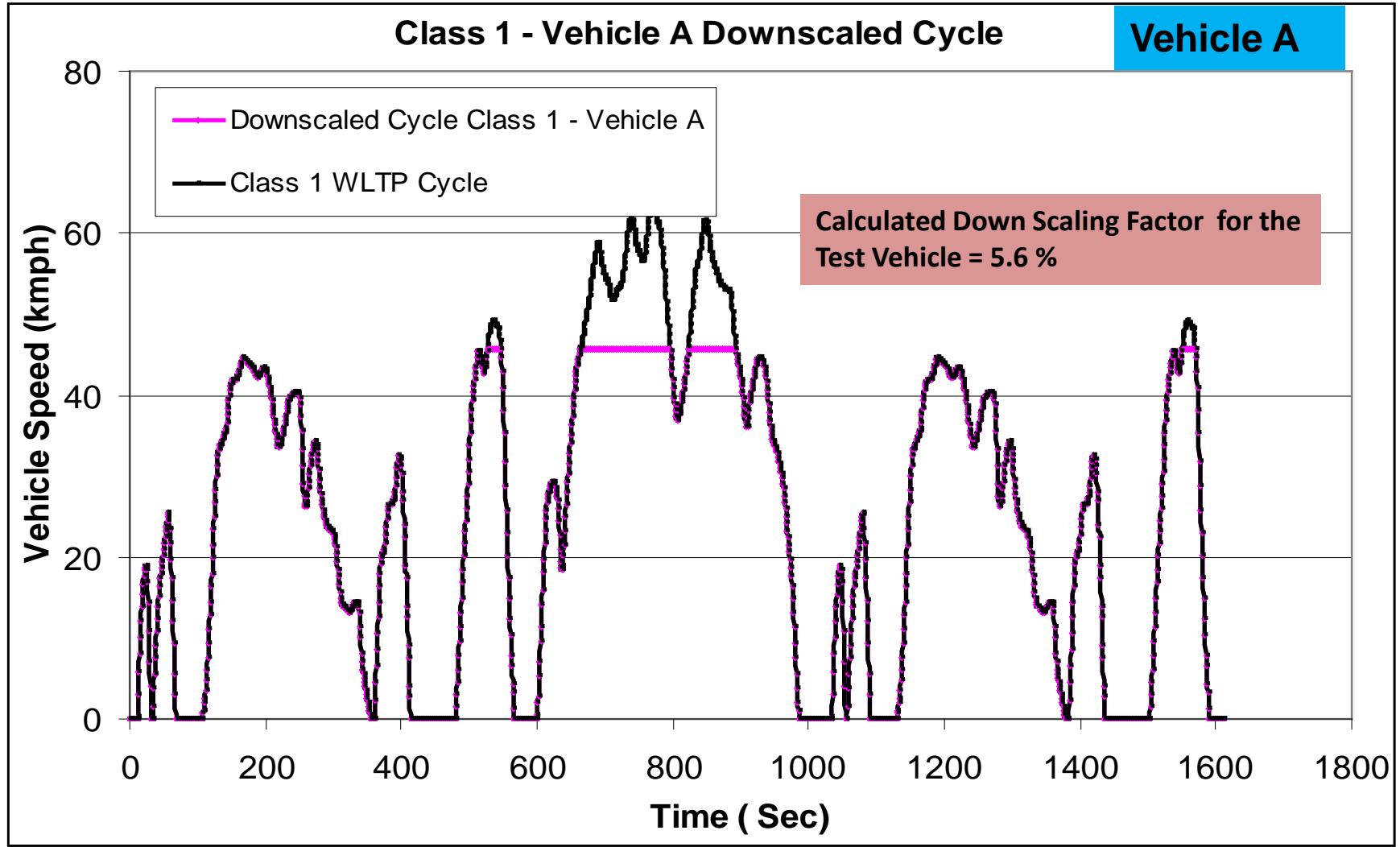
Form View

NUM

19:25
28-05-2013

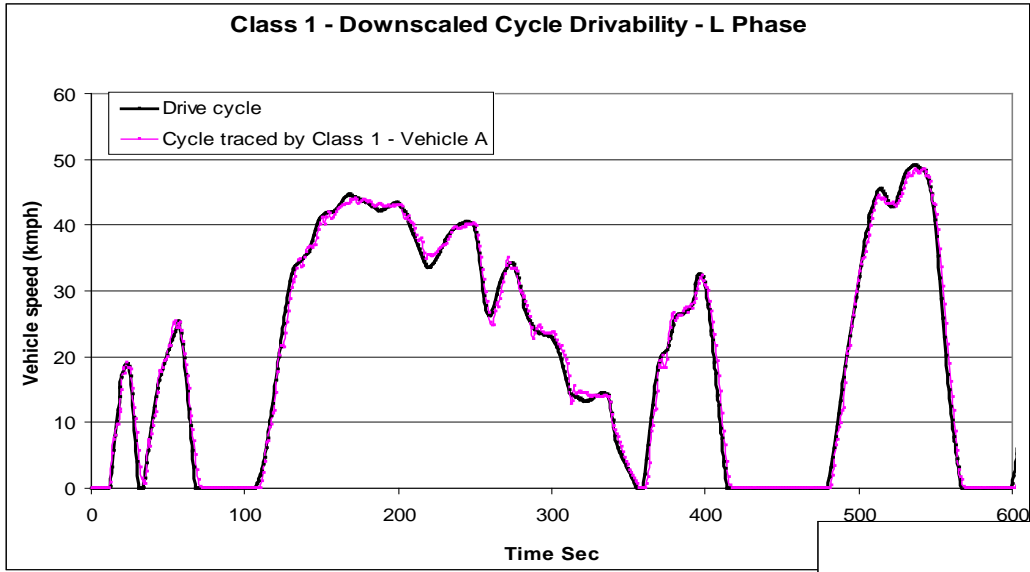
21%

Downscaling – Class I

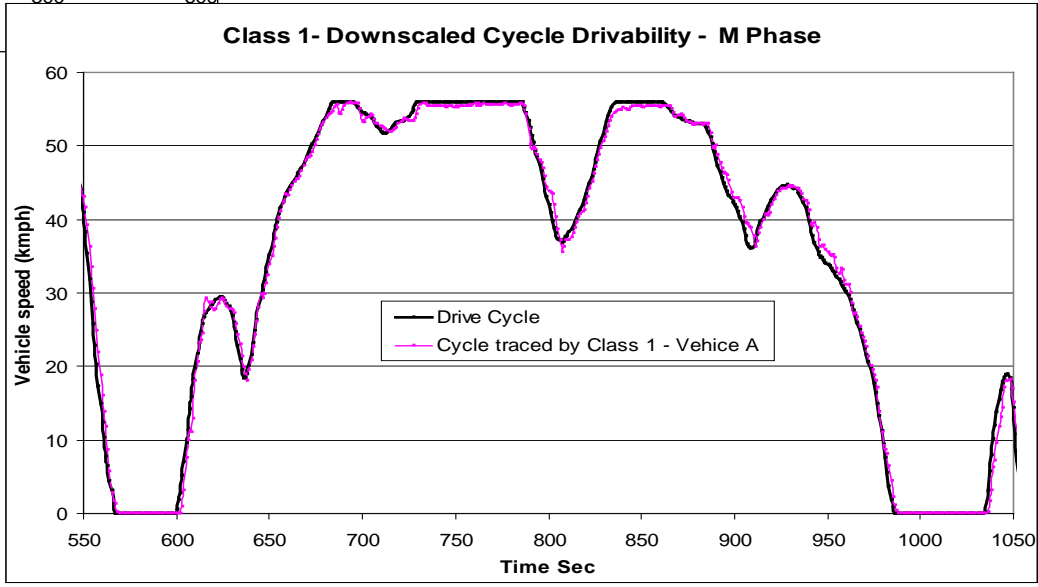


Downscaling leads to truncation of cycle similar to Capping. This needs correction similar to Class III Vehicle downscaling concept

Downscaling – Class I – Vehicle A Results



Calculated Down Scaling Factor for the Test Vehicle = 5.6 %



No drivability issues in L and M phases observed.

Example: Down scaling Factor Calculated for Class-1 Vehicle B

choose cycle option WLTC other cycles

check power curve 3 This option open with the power cu

The additional safety margin is fully applied at idling speed and then linearly reduced to 0 at rated speed

The power curve builds the basis of the gear use calculation

determine additional safety margin 0.0%

choose power curve Gio 6.8kW

choose vehicle_no 4

determine n_min_drive 1500

choose cycle class 1, version 2

choose vehicle speed cap 0.0%

modify test mass

modify road load coefficients

4

2

1020

calculate gear use

You have to insert a case name and then press the "check calculation settings" button in order to activate the "calculate gearshifts" button

case description Gio Passenger Bs3

Check calc settings **Calculate gearshifts** Check for calcul

Check results Check average n_norm **Export result**

Check for Pmax < Pres 1 Check for Pmax < Pres 2 Check wot pe

check v for Pres = Prated Check Pres Check n_norm

Check for high revs

Close

Microsoft Office Access

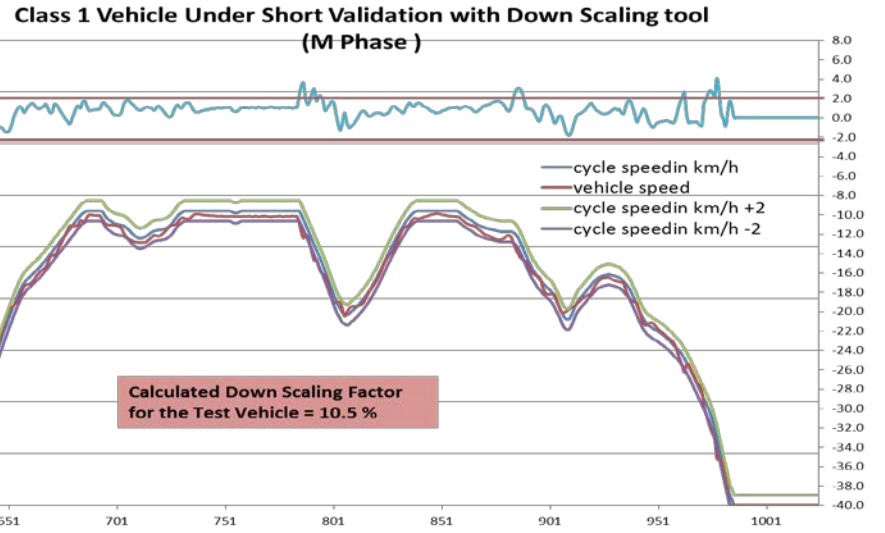
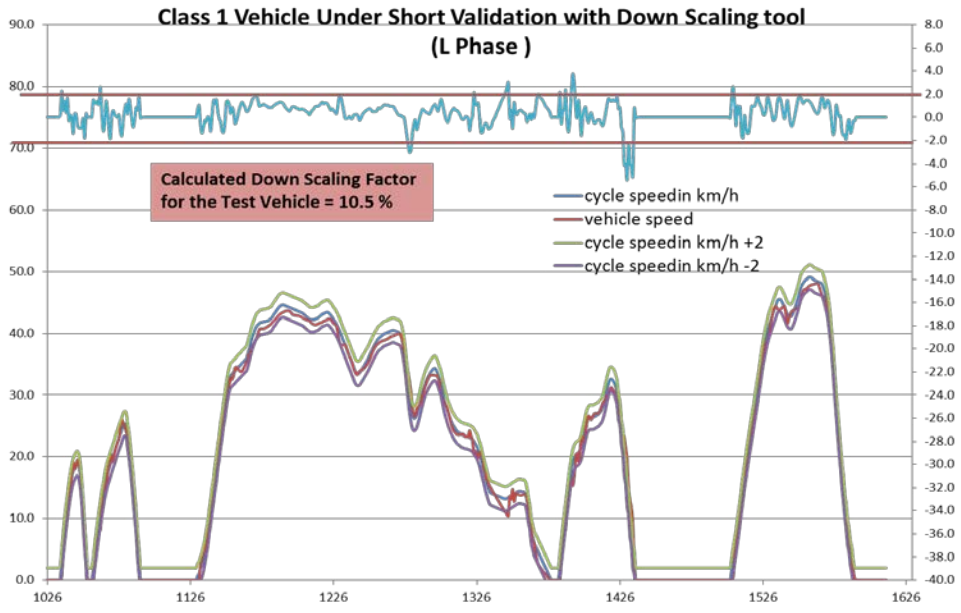
This vehicle would require 10.5 per cent downscaling!

OK

n_min speed d
minimum
minimum absolut 1500 mmr-1

class 1: pmr_kerb <= 22,
class 2: 22 < pmr_kerb <= 34,
class 3: pmr_kerb > 34

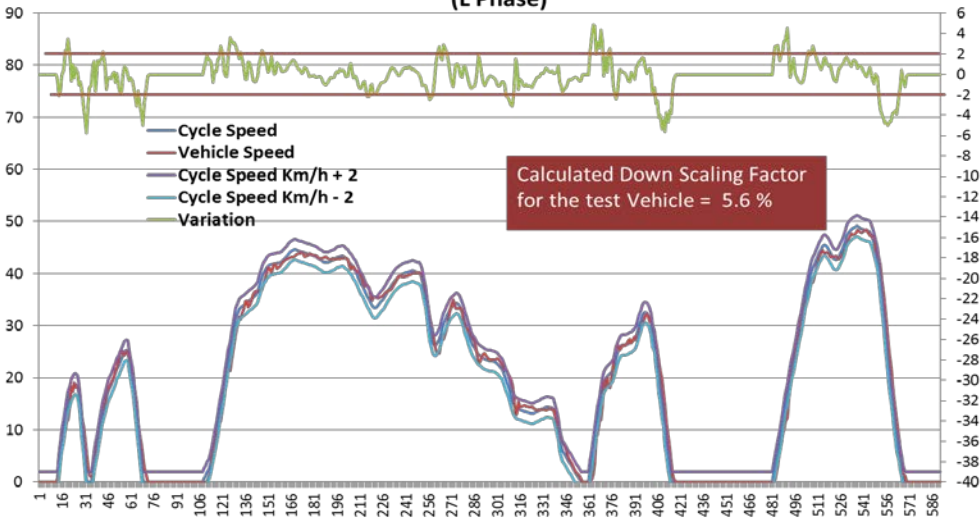
Downscaling – Class I – Vehicle B Results



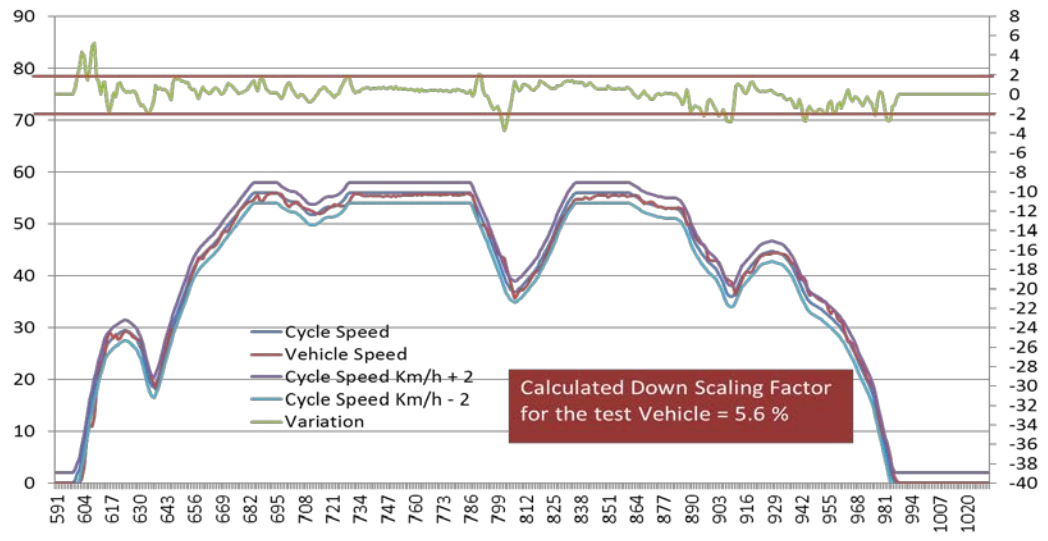
No drivability issues in L and M phases observed.

Downscaling – Class I – Vehicle C Results

Class 1 Vehicle under Short Validation with Down Scaling Tool (L Phase)



Class 1 Vehicle under Short Validation with Down Scaling Tool (M Phase)



No drivability issues in L and M phases observed.

Class II : Vehicle Validation Results

Example: Down scaling Factor Calculated for Class-2 Vehicle D

choose cycle option WLTC other cycles

check power curve This option open with the power cu

The additional safety margin is fully applied at idling speed and then linearly reduced to 0 at rated speed

The power curve builds the basis of the gear use calculation

determine additional safety margin

choose power curve

choose vehicle_no

determine n_min_drive

choose cycle

choose downscaling percentage

choose vehicle speed cap

modify test mass

modify road load coefficients

calculate gear use

You have to insert a case name and then press the "check calculation settings" button in order to activate the "calculate gearshifts" button

case description

Check calc settings Calculate gearshifts Check for calcul

Check results Check average n_norm Export result

Check for Pmax < Pres 1 Check for Pmax < Pres 2 Check wot pe

check v for Pres = Prated Check Pres Check n_norm

Check for high revs

Close

Microsoft Office Access

This vehicle would require 3.1 per cent downscaling!

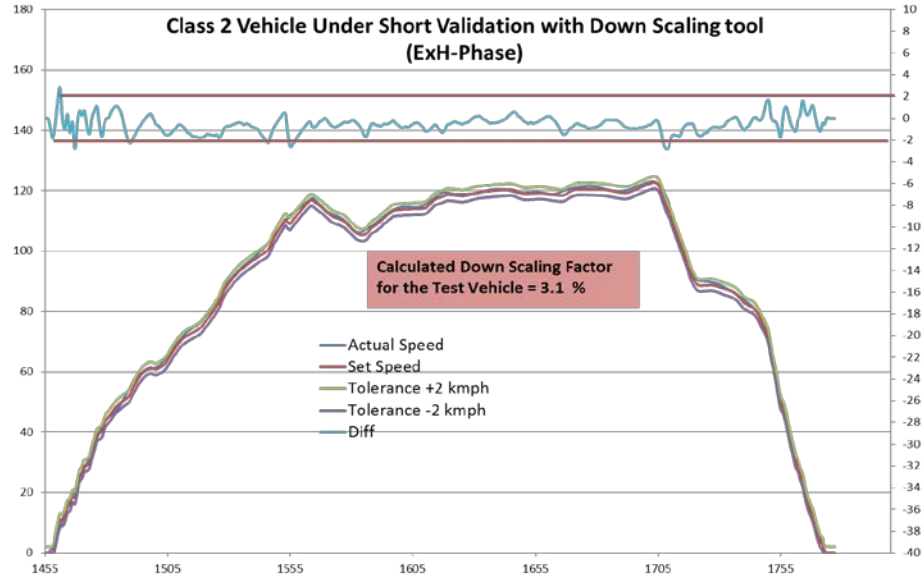
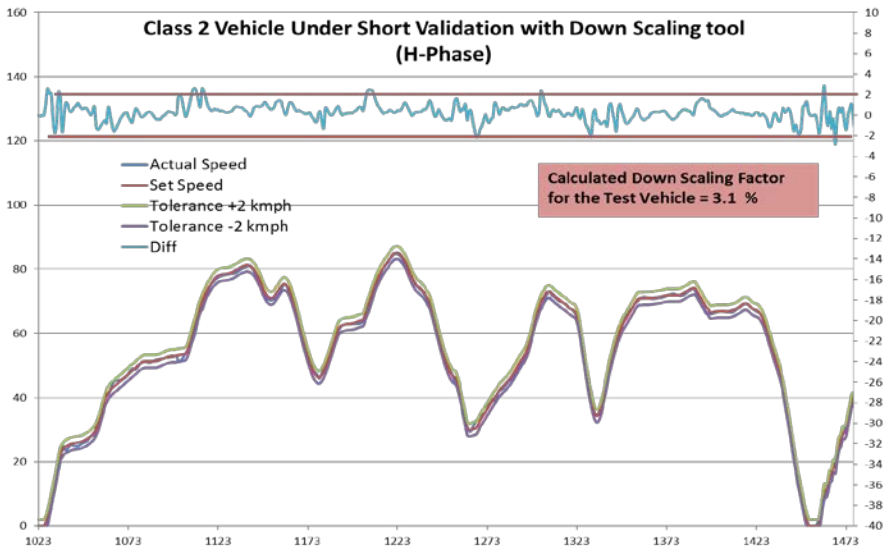
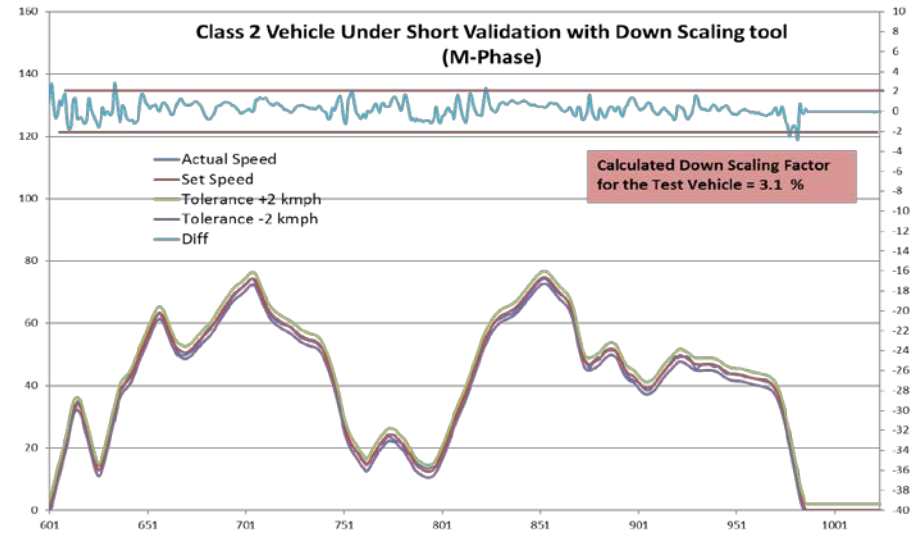
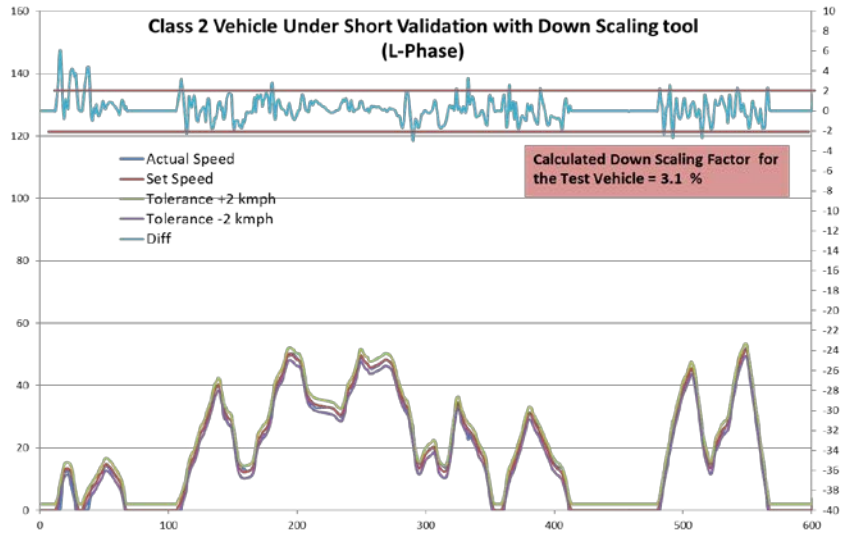
OK

n_min_drive minimum absolute 920 min-1

class 1: pmr_kerb <= 22,
class 2: 22 < pmr_kerb <= 34,
class 3: pmr_kerb > 34

If you choose 5%, the accelerations in the downscaling section are multiplied by (1 - p_DSC) and the vehicle speed trace is recalculated from the reduced accelerations. The values in the drop down list can be overwritten by any value up to 50%.

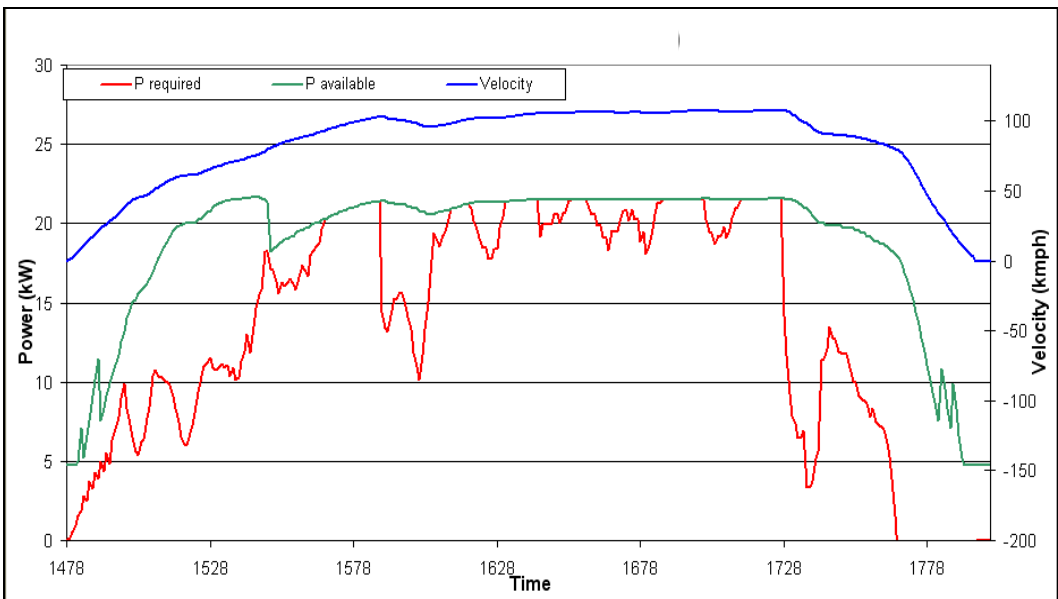
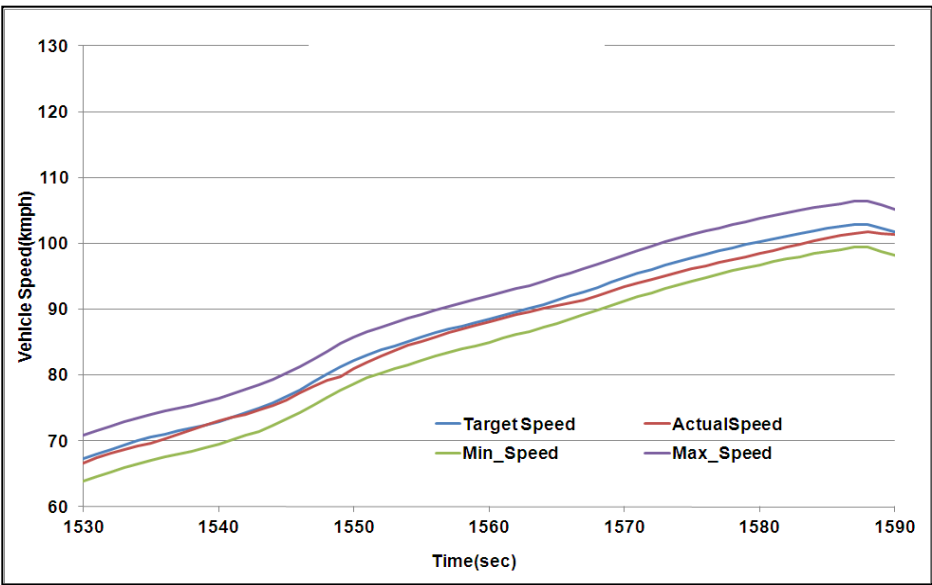
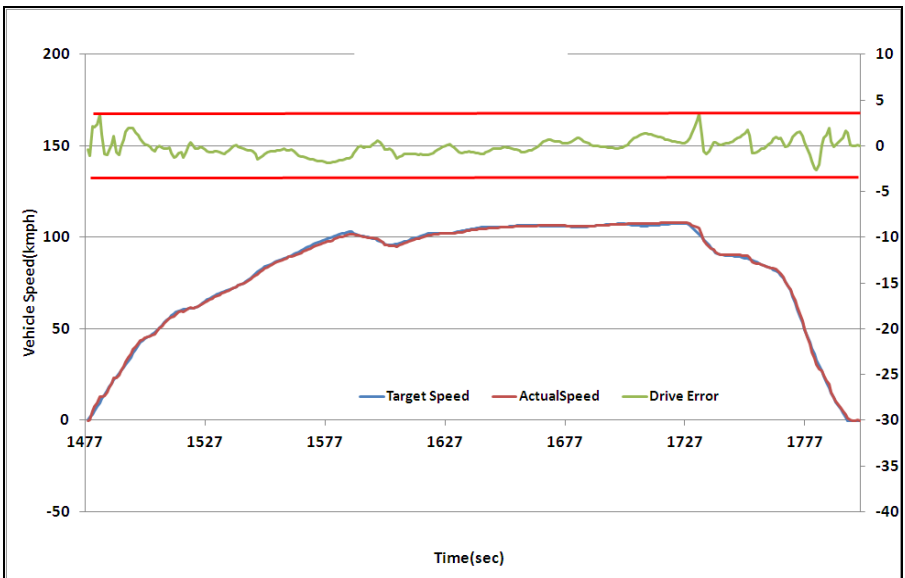
Downscaling – Class II – Vehicle D Results (Diesel Vehicle)



No drivability issues observed (Diesel Vehicle).

Test Results : Vehicle E - Class II (Gasoline Vehicle)

Vehicle E: Gasoline Class II – EXH Phase



Remarks

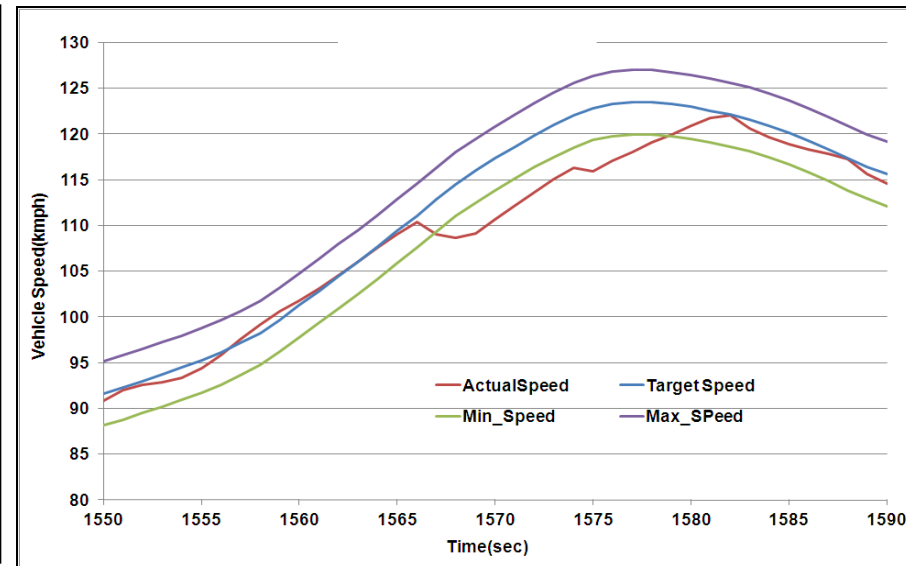
- 1. Cycle Traceability :
 - a. Steven Downscaling factor = 23 %
 - b. Vehicle able to follow the targeted trace
 - c. **40% of operation is in near WOT area** in EXH phase. Component protection area operation is very high

Class III : Vehicle Validation Results

Concerns with the New Tool

- A) N norm max: Set Value 120% in new tool, which leads to very high Engine RPM's, Engine hitting the rev limiter, resulting in errors

Vehicle F Gasoline Class III – EXH Phase

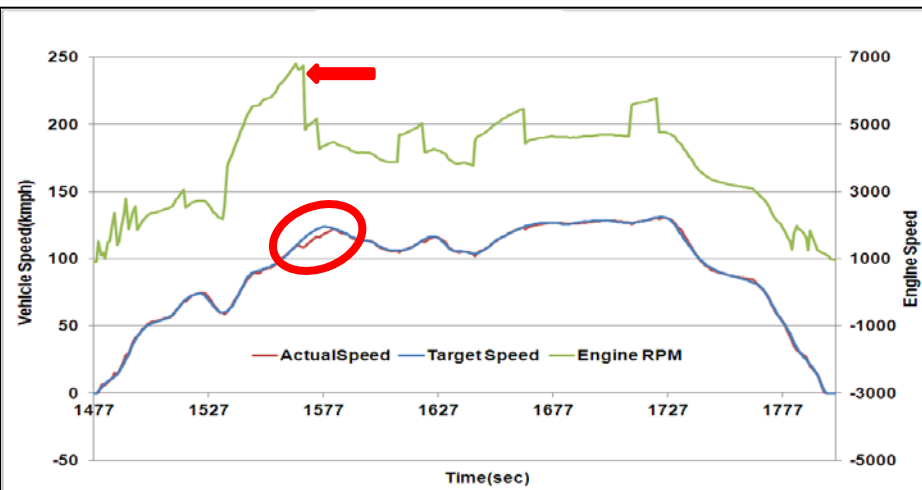


- This is not a natural driving behavior!
- This Results in driving error from target
- Creates artificial downscaling requirements

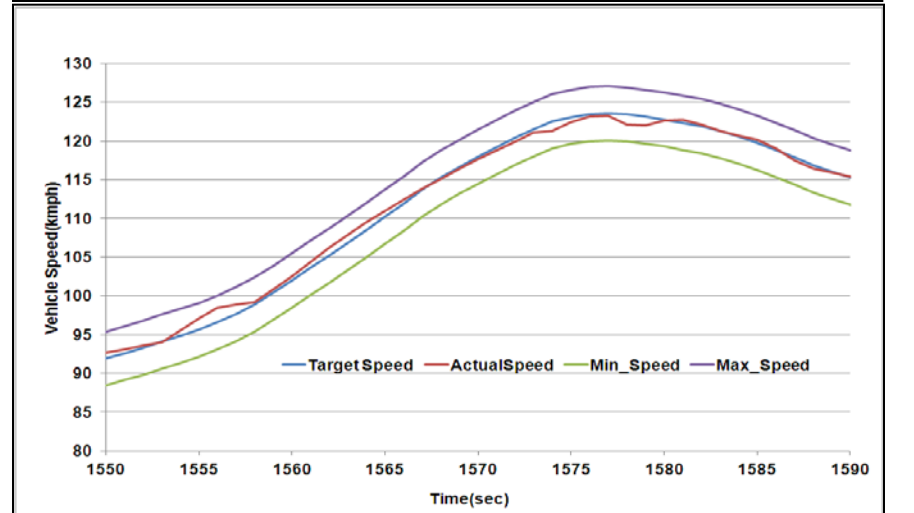
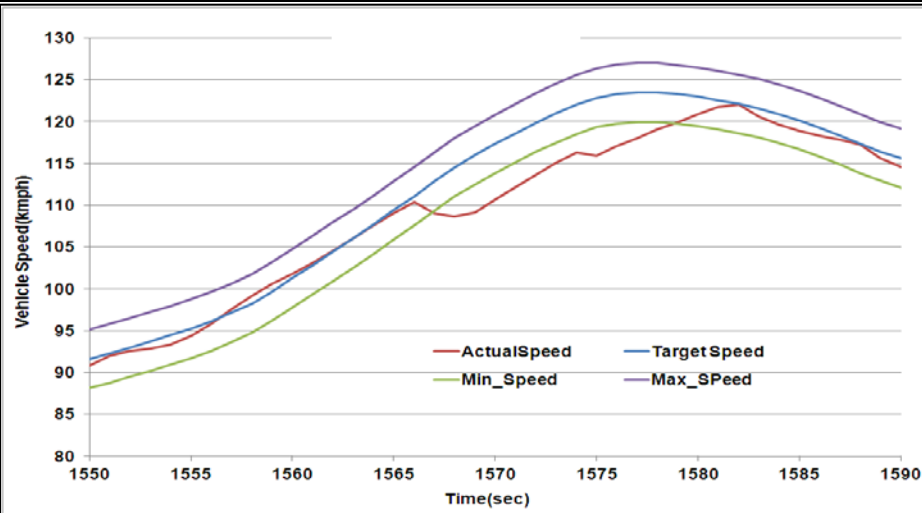
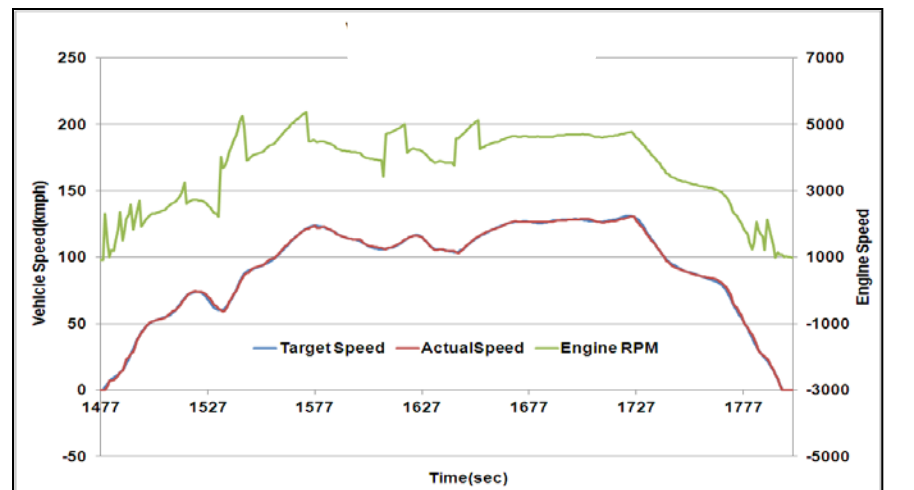
Proposal: N-Norm max set value of 90% as in previous tool should be used

Comparison of N_norm_max =120% and 90% - Vehicle F Class III

Vehicle F : N_norm_max =120%



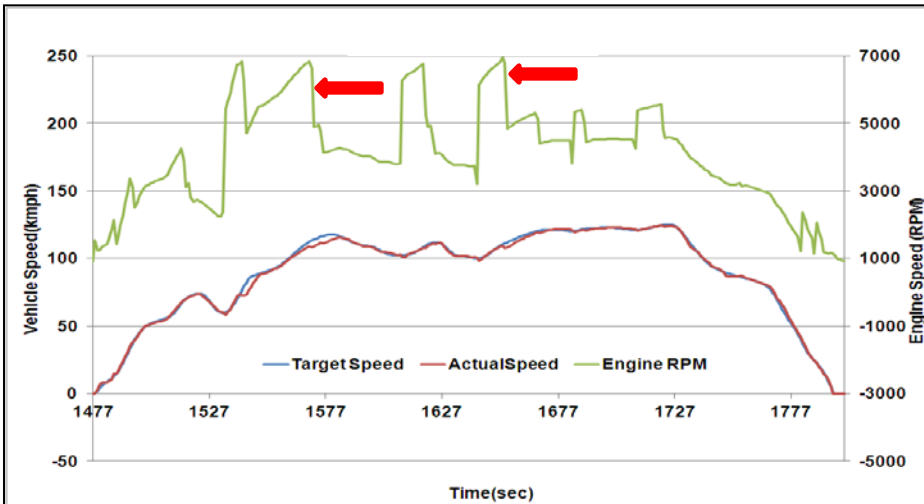
Vehicle F : N_norm_max =90%



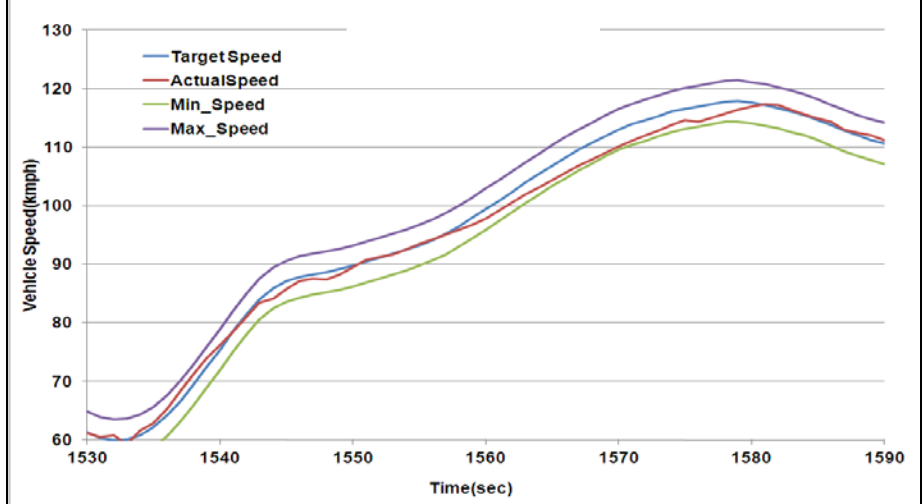
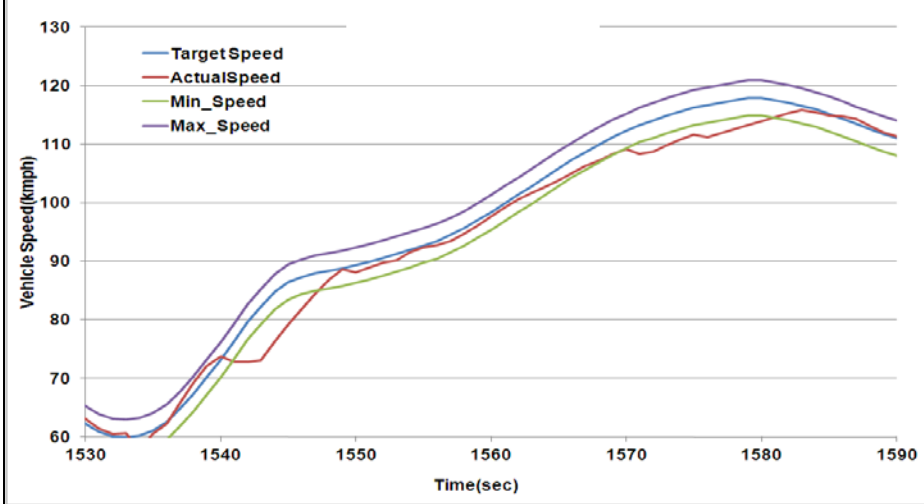
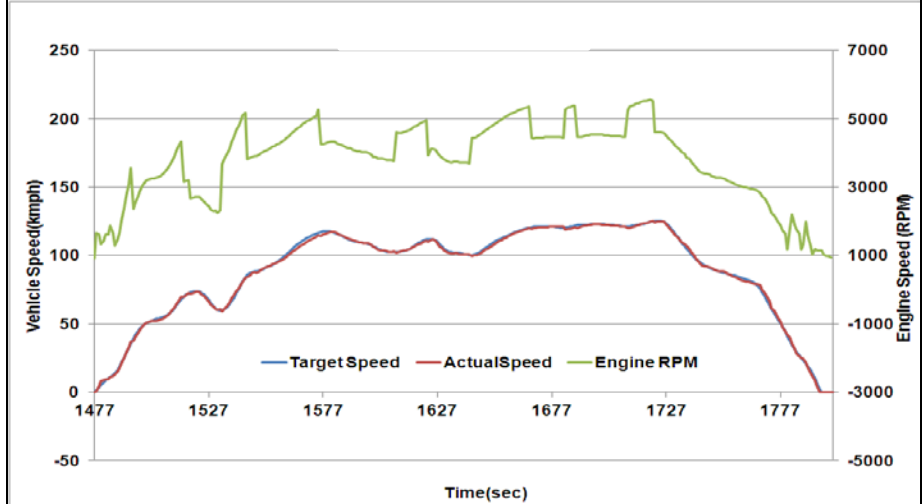
1. With N_norm_max=120% Engine RPM in cycle reaches maximum permissible limit.
2. Fuel Cut results in sudden power loss and deviation from targeted trace, whereas with 90 % n_norm_max vehicle follows the trace . With 120%, artificial downscaling requirements get created

Comparison of N_norm_max =120% and 90% - Vehicle G Class III

Vehicle G : N_norm_max =120%



Vehicle G : N_norm_max =90%



1. With N_norm_max=120% Engine RPM in cycle reaches maximum permissible limit
2. Fuel Cut results in sudden power loss and deviation from targeted trace, whereas with 90 % n_norm_max vehicle follows the trace.

Concerns with the New Tool

B. R max : $r_{0_} > 1$ for downscaling applicability.

This means that demand power should be higher than engine rated power

Downscaling proposal



- The downscaling factor f_{dsc} is calculated using the following equation:
 - $f_{dsc} = 0$, if $r_{max} < r_0$
 - $a_1 * r_{max} + b_1$, if $r_{max} \geq r_0$
- The calculation parameter/coefficients r_0 , a_1 and b_1 are as follows:.
 - $r_0 = 1.053$, $a_1 = 0.54$, $b_1 = -0.5385$ for class 1
 - $r_0 = 1.022$, $a_1 = 0.532$, $b_1 = -0.5133$ for class 2
 - $r_0 = 1.024$, $a_1 = 0.63$, $b_1 = -0.615$ for class 3.
- The r_0 values are chosen so that the downscaling starts with $f_{dsc} = 3\%$.

Class	r_0
Class I	1.053
Class II	1.022
Class III	1.024

r_{max} is calculated using the following equation:

$$r_{max} = P_{req, max, i} / P_{rated}$$

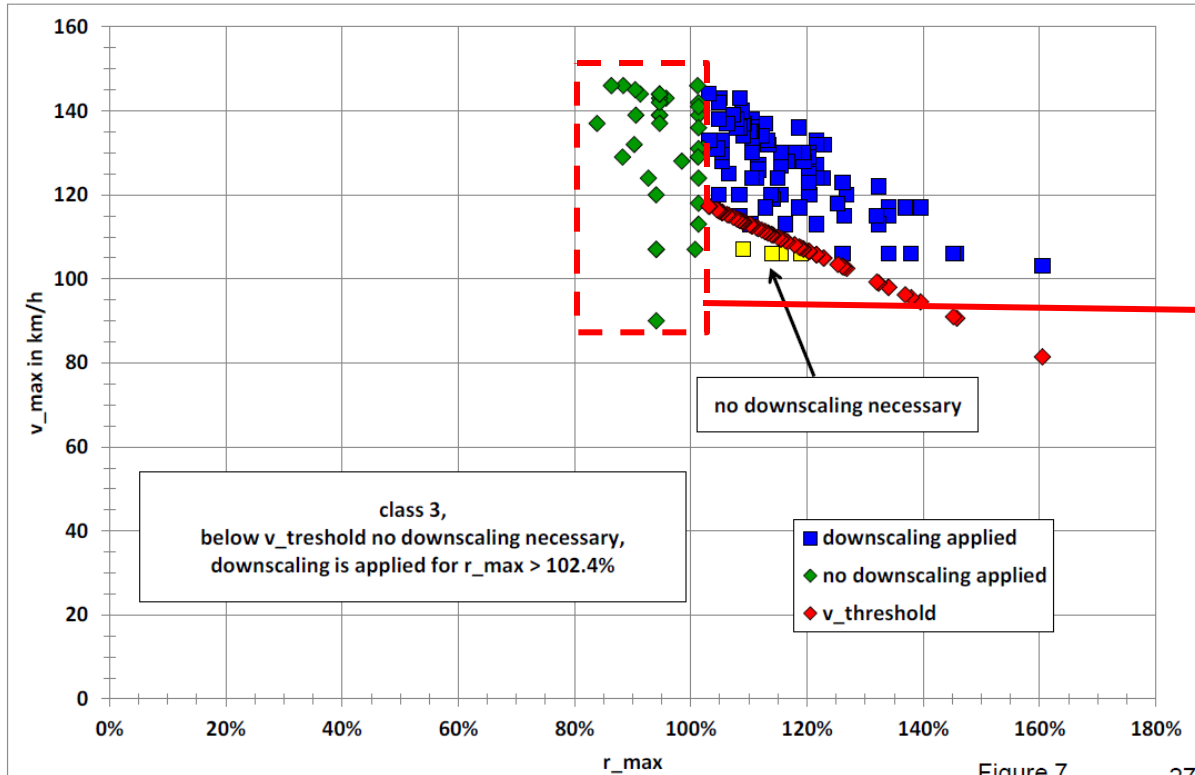
Downscaling will be required if $P_{req, max, i}$ is higher than P_{rated} , with a margin

Concerns with the New Tool

B. $R_{max} : r_{0_} > 1$ for downscaling applicability.

This means that demand power should be higher than engine rated power

v_{max} vs r_{max} , class 3



Vehicles may be able to trace the cycle but will have high P_{WOT} rates

Example: Vehicle with $P_{req,max,i} / P_{rated} = 89\%$.
Vehicle available power = 90%.
Difference is only 1% which will result in high P_{WOT} .

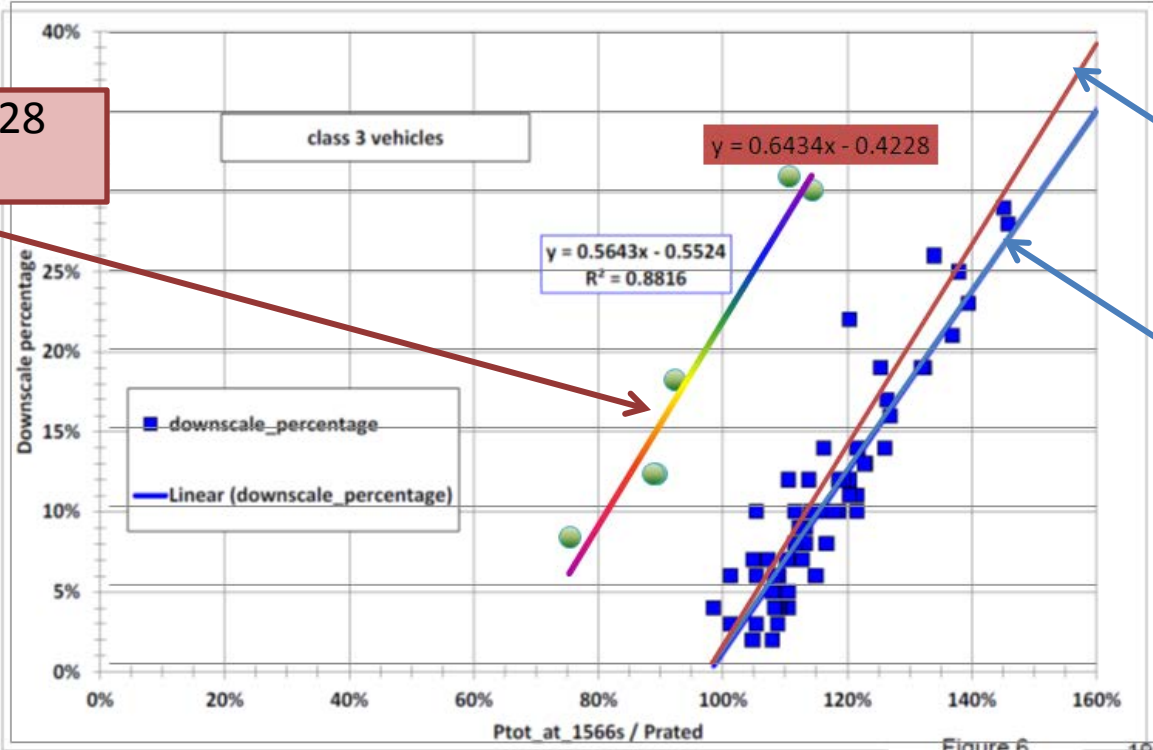
Downscaling will be required if $P_{req,max,i}$ is higher than P_{rated} , with a margin

Proposal 1– Considering operation times > 90% of available Power

f_dsc versus r_max, class 3



$Y=0.634x-0.4228$
 $R^2=0.945$



Target line
Proposal by HS

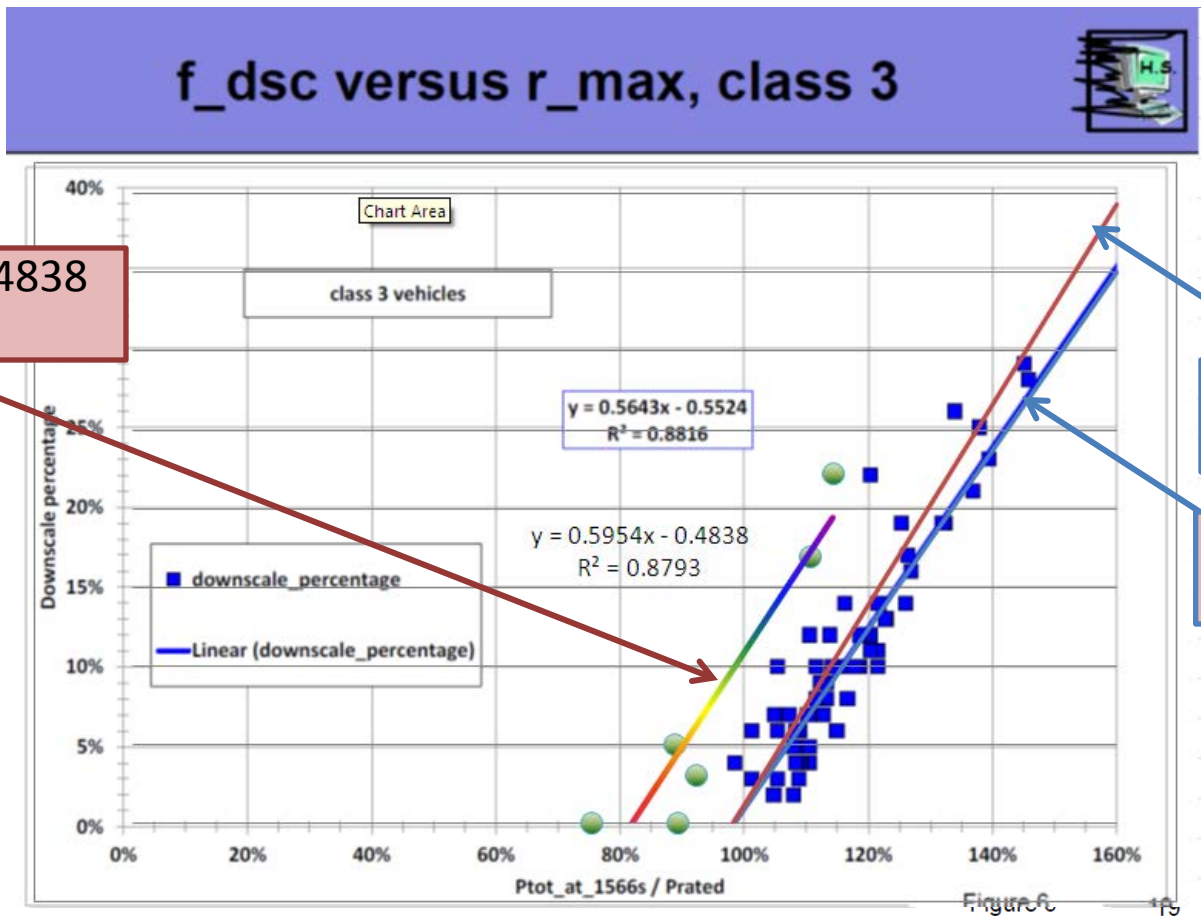
Regression line
by HS

Normal running of vehicles as per road data collected shows near WOT operation < 2%

Considering vehicle running above 90% of available power for ~5% time in EXH phase

Proposal: May give some undue advantage to some vehicles (dropped). EXH operations with required power >90% of available power for 5% of times is equivalent to around 3~4% on overall cycle

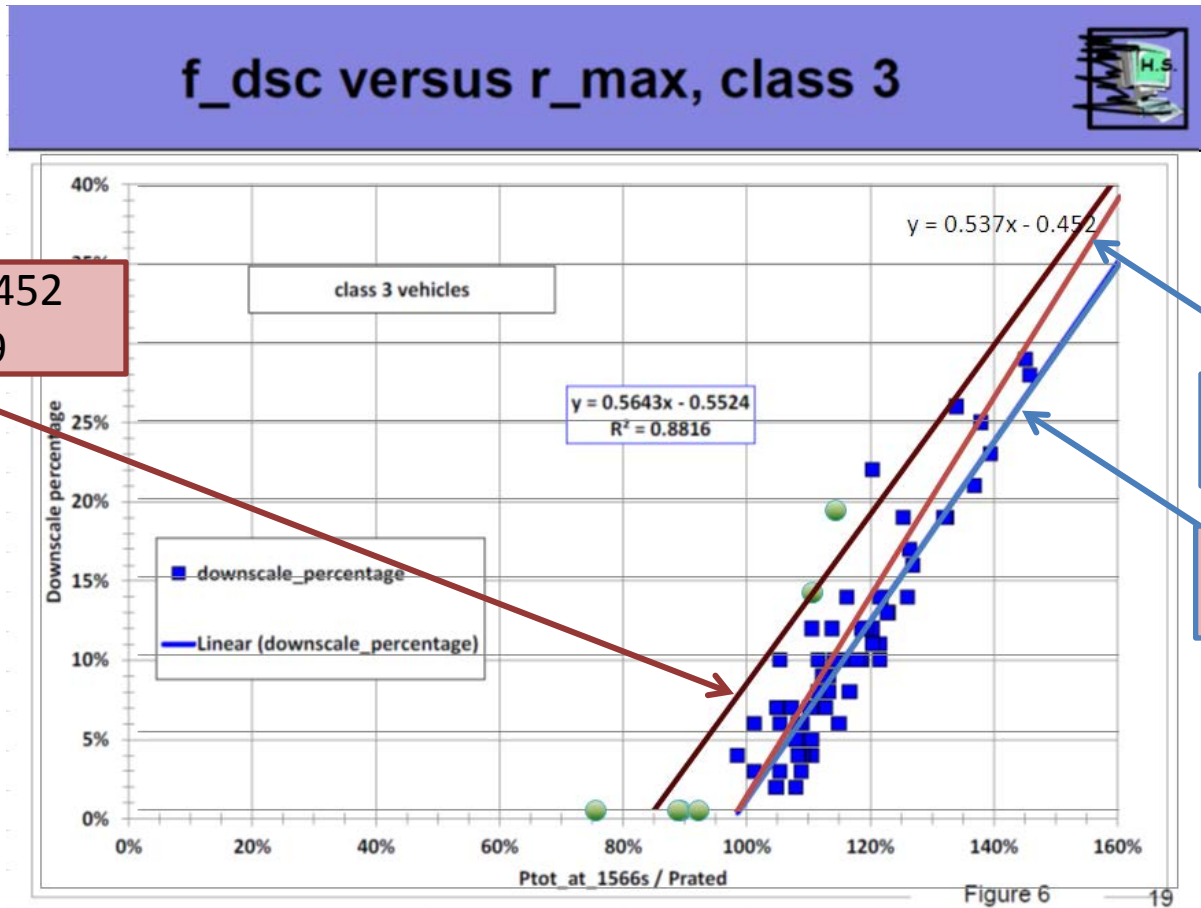
Proposal 2– Considering operation times > 95% of available Power



In order to rationalize further, operation times only above 95% of available power were considered. Criteria was to limit these conditions to 5% of operation times in EXH phase

Proposal: Looks reasonable. EXH operations with required power >95% of available power for 5% of times is equivalent to around 2% on overall cycle.

Proposal 3– Considering operation times > 95% of available Power



In order to rationalize even further, criteria was changed from 5% to 10% of operation times in EXH phase

Proposal: Will be a worst case criteria for real borderline vehicles. EXH operations with required power >95% of available power for 10% of times is equivalent to around 3% on overall cycle.

Steven Proposal vs Proposal 2 & 3

Parameter	Vehicle	Steven-Proposal	Proposal 2 (EXH P_WOT 5%)	Proposal 3 (EXH P_WOT 10%)
Down- Scaling factor	F	0%	4.37%	2.38%
	G	7.90%	17.17%	13.92%
	X1	10.20%	19.38%	15.91%
	X2	0%	0.00%	0.00%
WOT Operation EXH Phase	F	5.60%	6.8%	7.1%
	G	15.50%	3.1%	7.7%
	X1	27.90%	10.2%	16.1%
	X2	4.00%	4.00%	4.00%
WOT Operation Cycle	F	1.60%	1.8%	1.9%
	G	4.60%	2.1%	3.1%
	X1	6.1%	2.9%	3.9%
	X2	0.70%	0.70%	0.70%
Max Cycle Speed Kmph	F	131.3	128.1	129.6
	G	125.6	119.0	121.3
	X1	122.4	117.4	119.8
	X2	131.3	131.3	131.3

Based on short validation for downscaling tool, India recommends Proposal 3 for Class III Vehicles. This change does not affect vehicles $\geq 1.0L$ Engine capacities.

Summary of India's Proposal

- 1) N-Norm_max criteria need to be reverted from 120% back to 90% (original value) to avoid unnatural driving conditions and align with real life driving**
- 2) Based on short validation for downscaling tool, India recommends Proposal 3 for Class III Vehicles (considering 10% WOT operation in EXH Phase and approximately 3% in overall cycle time).**
- 3) Similar criteria to be applied for Class II Vehicles**
- 4) Class I downscaling shows truncation of cycle speed instead of downscaling of cycle. Needs uniformity of concept similar to Class III**

Thank You for Your Attention