GRBIG-ASEP-08-003

August 2007

PRESENTATION OF

INTERNATIONAL ORGANIZATION OF MOTOR VEHICLE MANUFACTURERS

OICA-test concept for ASEP

- **Scope:**
  - The OICA-Test is meant to detect noise deviations from the “normal physical behaviour” of a specific vehicle. Due to the large variety of vehicle design, the definition of the “normal behaviour” must be defined for each concrete vehicle .
  - Deviations from the “normal behaviour” are understood as a result of “active” tuning of components, specially the exhaust system.
  - This might lead to sound emissions at driving conditions different from the type approval test, which cannot be expected from the type approval test result.
  - The test is in line with the approved wording of GRB for ASEP as written down in document *TRANS-WP29-GRB-2005-02r2e*
- **Practical considerations:**
  - The test should be easy in application
  - Work load must be limited, which requires a balance between the precision of test and the time needed for carrying out the test.

- **Step 0:**
  - Establish whether a test is needed for the presented vehicle type.

- **Step 1:**
  - Check, whether the presented vehicle is potentially critical and need more detailed testing?
  - Measurement of sound emission at 4 points equally distributed between the Annex 3 test area and a test borderline, which need to be defined.
  - If the vehicle passes Step 2 the vehicle is uncritical and Step 3 is not needed.

- **Step 2:**
  - More testing provides a detailed picture of the sound behaviour.
  - The sound emission at additional four points, will deliver information at 9 to 10 points of the vehicle sound map under full throttle condition, which are 1 (2) Values from Annex 3 plus 4 values from Step 1 plus 4 values from Step 2

- **It is possible to justify the sound behaviour from these measurements.**

Theoretical Approach - Step 1

1500	Nbb_wot_i	72,0	Nbb_wot_i+1	0%	Reduction
	Lmax_i		Lmax_i+1	4,0	dB/1000rpm

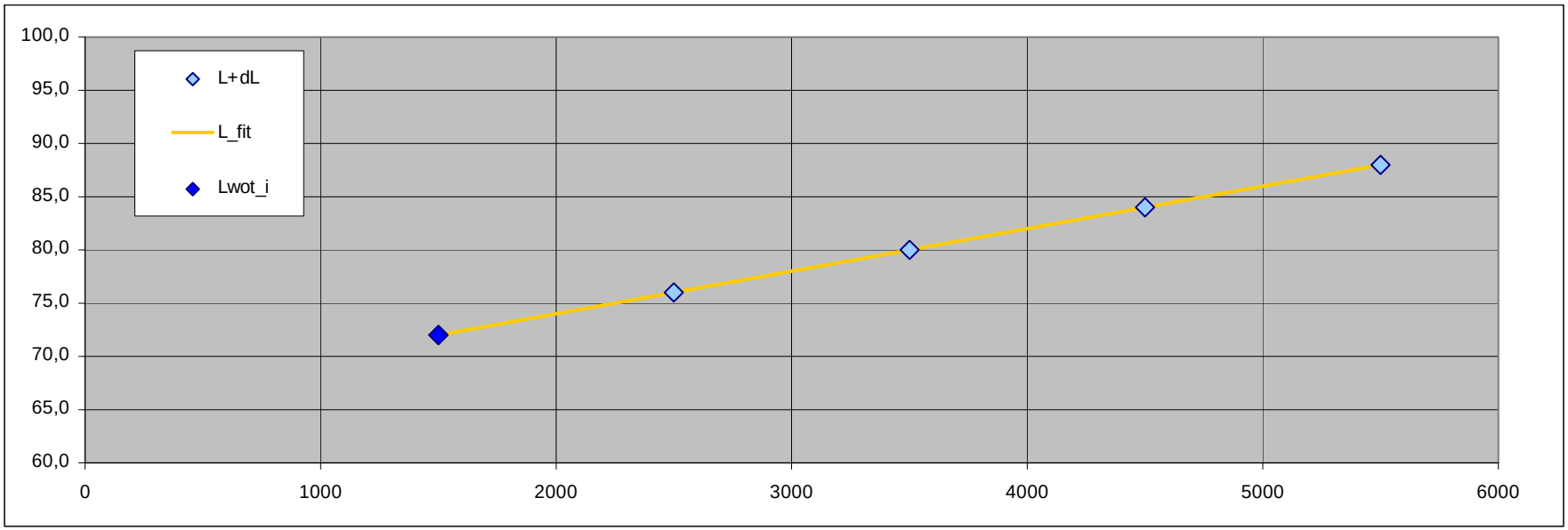
Allowed Margin

3	dB
-3	dB

Theoretical Example for STEP 1

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Delta
1	**1500**	**72,0**		**72,0**		**72,0**	0,0
2	2500	76,0	0,0	**76,0**	4,0	**76,0**	0,0
3	3500	80,0	0,0	**80,0**	4,0	**80,0**	0,0
4	4500	84,0	0,0	**84,0**	4,0	**84,0**	0,0
5	**5500**	**88,0**	0,0	**88,0**	4,0	**88,0**	0,0

Step 1 o.k; Vehicle ASEP conform



Theoretical Example for STEP 1

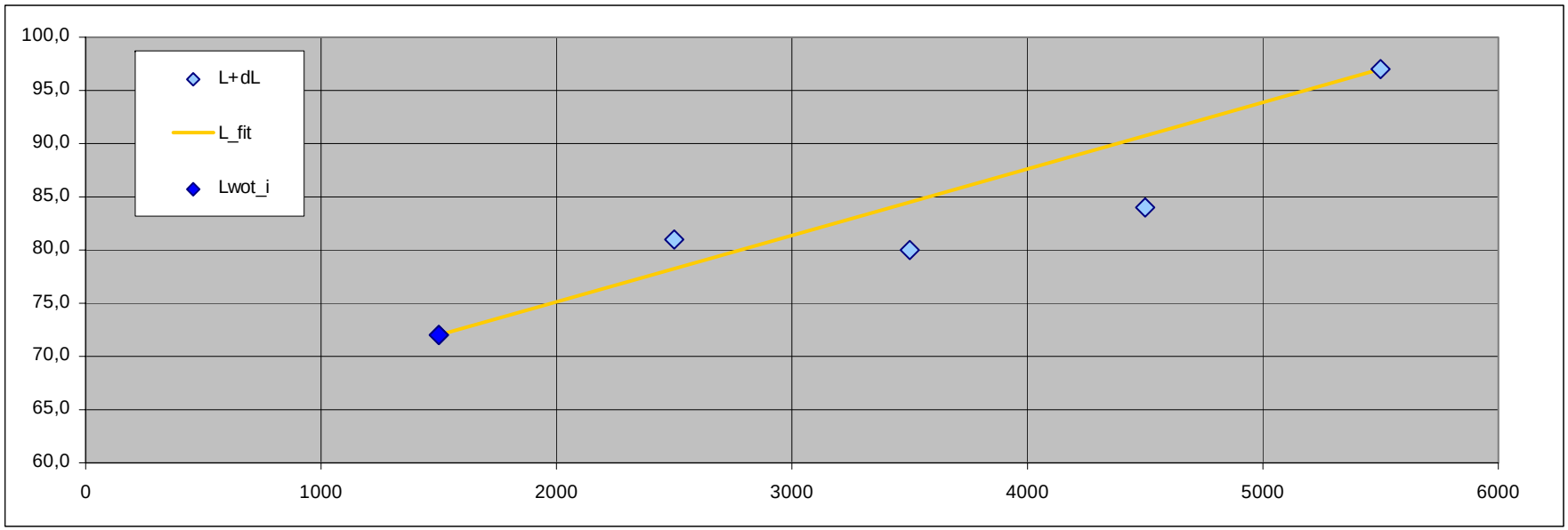
Theoretical Approach - Step 1

1500	Nbb_wot_i	**72,0**	Nbb_wot_i+1	**0%**	Reduction
	Lmax_i		Lmax_i+1	6,3	dB/1000rpm

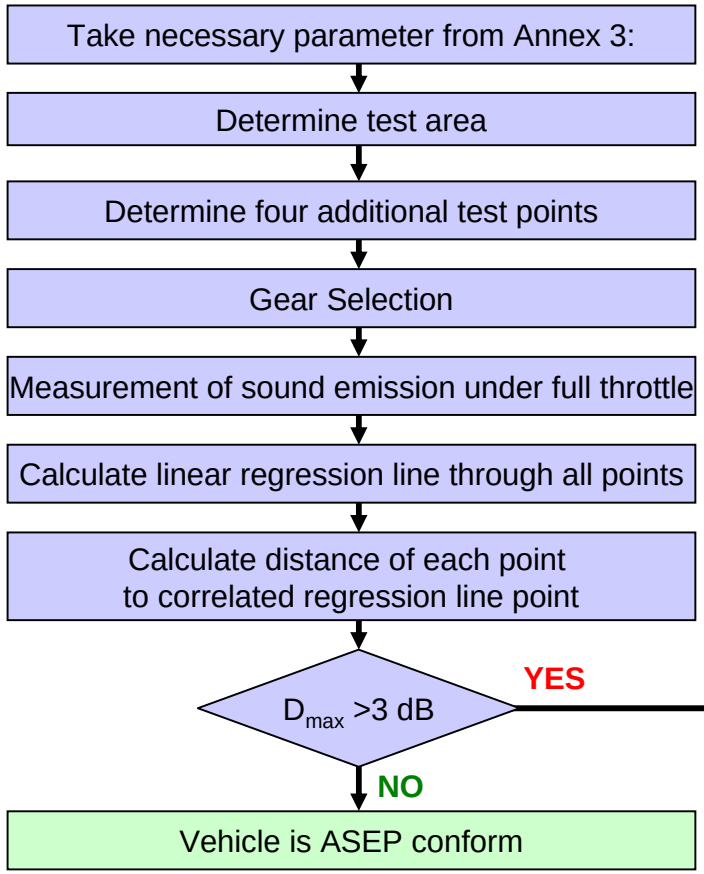
Allowed Margin	
3	dB
-3	dB

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Delta
1	**1500**	**72,0**		**72,0**		**72,0**	0,0
2	2500	76,0	**5,0**	**81,0**	9,0	**78,3**	2,8
3	3500	80,0	**0,0**	**80,0**	-1,0	**84,5**	**-4,5**
4	4500	84,0	**0,0**	**84,0**	4,0	**90,8**	**-6,8**
5	**5500**	**88,0**	**9,0**	**97,0**	13,0	**97,0**	0,0

Step 1 failed; Step 2 needed



Flow chart - Step 2 Quick Check



- **Annex 3 parameter:**
  L_{wot_i}; L_{wot_i+1}; $n_{bb\_wot\_i}$; $n_{bb\_wot\_i+1}$; PMR (All values refer to line BB)
- **End of test area:**
  given by: $N_{bb\_max\_ASEP} = f(PMR)$; V_{bb_max}
- **Target engine speed for each point:**
  $N_{bb\_ASEP;k} = N_{bb\_wot\_i} + ¼ * k * (N_{bb\_max\_ASEP} - N_{bb\_wot\_i})$ +/- [150] rpm
- **Gear selection: see further down**
- **Sound measurements:**
  Measure in the specified gear(s) under full throttle at the specified engine speeds $N_{bb\_ASEP;k}$
- **Linear Regression:**
  includes L_{wot_i} and L_{wot_i+1}
- **Maximum deviation from regression line:**
  $D_{max} = MAX (| L_{meas;k} - L_{reg;k} |;|L_{wot\_i} - L_{reg\_wot\_i}|;|Lwot\_i+1 - Lreg\_wot\_i+1|)$

Theoretical Approach - Step 1

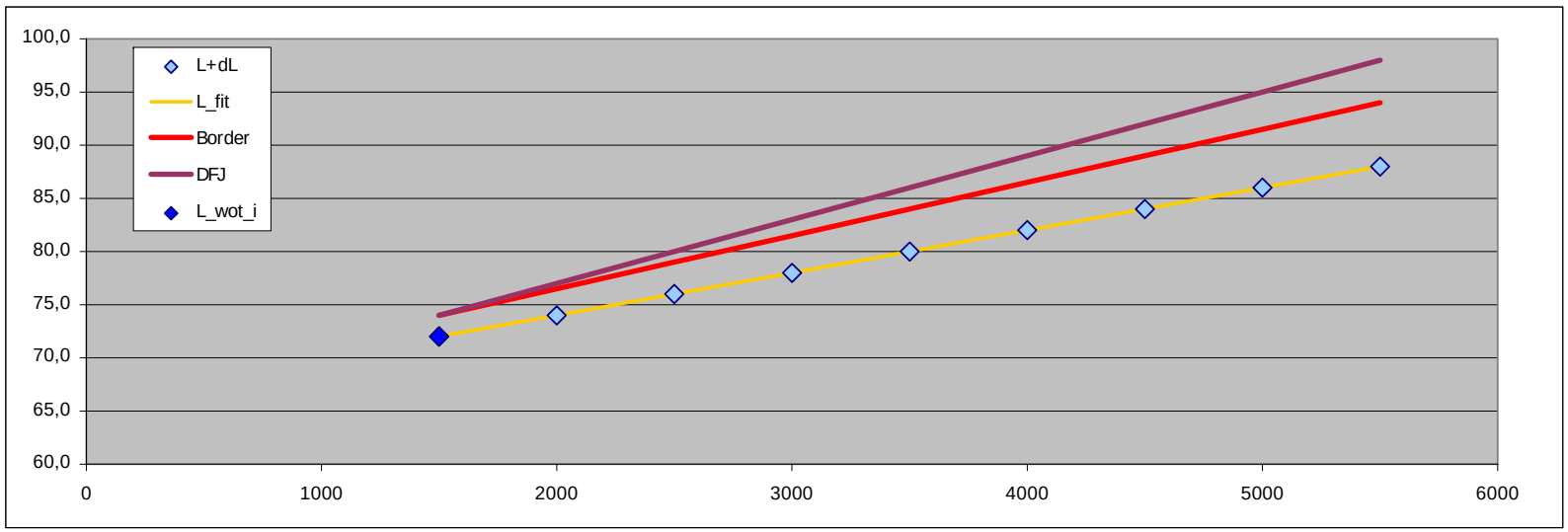
1500	Nbb_wot_i	72,0	Nbb_wot_i+1	30%	Reduction
	Lmax_i		Lmax_i+1	4,0	dB/1000rpm

Margin	2,0	dB
Add Slope	1,0	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	**5,0**	dB/1000rpm

Theoretical Example for STEP 2

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	**1500**	**72,0**		**72,0**		**72,0**	**74,0**	**74,0**	**-2,0**
2	2000	74,0	0,0	**74,0**	4,0	**74,0**	**76,5**	**77,0**	**-2,5**
3	2500	76,0	0,0	**76,0**	4,0	**76,0**	**79,0**	**80,0**	**-3,0**
4	3000	78,0	0,0	**78,0**	4,0	**78,0**	**81,5**	**83,0**	**-3,5**
5	3500	80,0	0,0	**80,0**	4,0	**80,0**	**84,0**	**86,0**	**-4,0**
6	4000	82,0	0,0	**82,0**	4,0	**82,0**	**86,5**	**89,0**	**-4,5**
7	4500	84,0	0,0	**84,0**	4,0	**84,0**	**89,0**	**92,0**	**-5,0**
8	5000	86,0	0,0	**86,0**	4,0	**86,0**	**91,5**	**95,0**	**-5,5**
9	5500	88,0	0,0	**88,0**	4,0	**88,0**	**94,0**	**98,0**	**-6,0**

Step 2 o.k
Vehicle ASEP conform



Theoretical Approach - Step 1

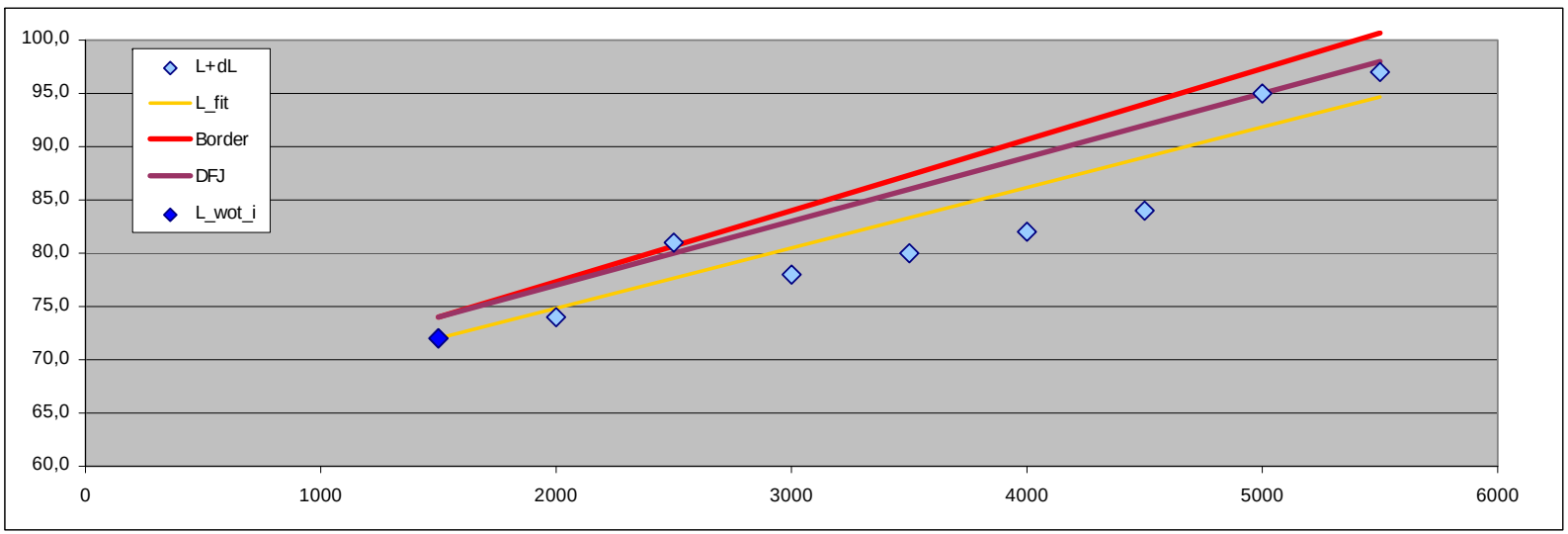
1500	Nbb_wot_i	72,0	Nbb_wot_i+1	30%	Reduction
	Lmax_i		Lmax_i+1	5,7	dB/1000rpm

Margin	2,0	dB
Add Slope	1,0	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	6,7	dB/1000rpm

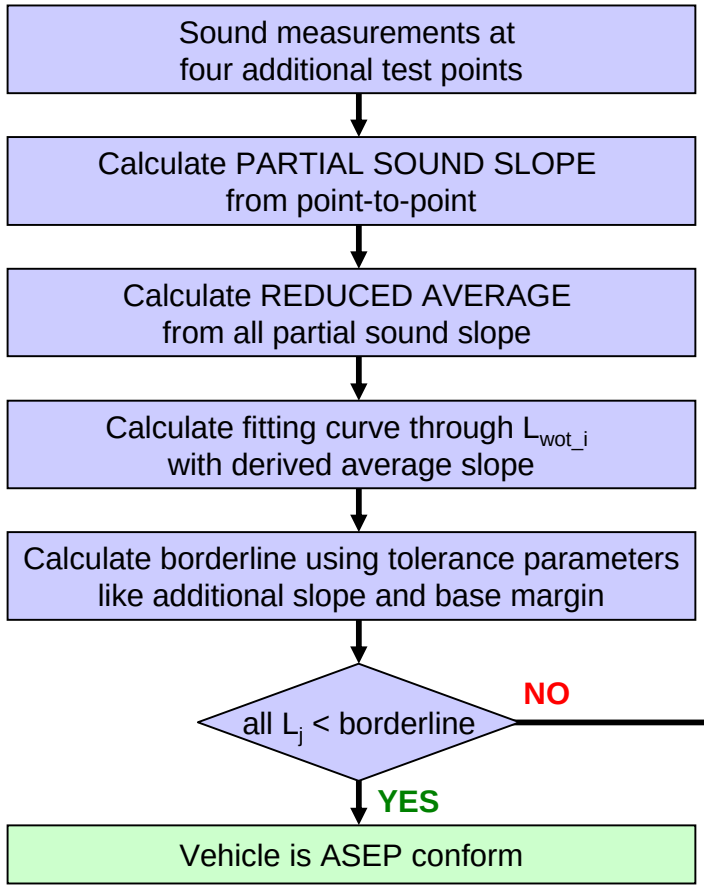
Theoretical Example for STEP 2

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	**1500**	**72,0**		**72,0**		**72,0**	**74,0**	**74,0**	**-2,0**
2	2000	74,0	0,0	**74,0**	4,0	**74,8**	**77,3**	**77,0**	**-3,3**
3	2500	76,0	5,0	**81,0**	14,0	**77,7**	**80,7**	**80,0**	**0,3**
4	3000	78,0	0,0	**78,0**	-6,0	**80,5**	**84,0**	**83,0**	**-6,0**
5	3500	80,0	0,0	**80,0**	4,0	**83,3**	**87,3**	**86,0**	**-7,3**
6	4000	82,0	0,0	**82,0**	4,0	**86,2**	**90,7**	**89,0**	**-8,7**
7	4500	84,0	0,0	**84,0**	4,0	**89,0**	**94,0**	**92,0**	**-10,0**
8	5000	86,0	9,0	**95,0**	22,0	**91,8**	**97,3**	**95,0**	**-2,3**
9	5500	88,0	9,0	**97,0**	4,0	**94,7**	**100,7**	**98,0**	**-3,7**

Step 2 failed
Vehicle NOT ASEP conform



- **Flow chart - Step 3 Full Test**



- **Target engine speed for additional points:**
  Nbb_ASEP;j = Nbb_wot_i + 1/8 * j * (Nbb_max_ASEP - Nbb_wot_i) +/- [150] rpm with j = {1;3;5;7}
- **Partial sound slope:**
  $dL/dN_j = (L_{ASEP\_j+1} - L_{ASEP\_j}) / (N_{ASEP\_j+1} - N_{ASEP\_j})$
- **Reduced average slope:**
  Calculation of average slope but disregarding the biggest deviations
- **Fitting curve using the reduced average slope:**
  Assumed to be the “most realistic sound slope” for the specific vehicle
- **Borderline:**
  Although a political subject, the examples later provide a possible borderline for better understanding

VERIFICATION USING REAL TEST DATA

Example 0205

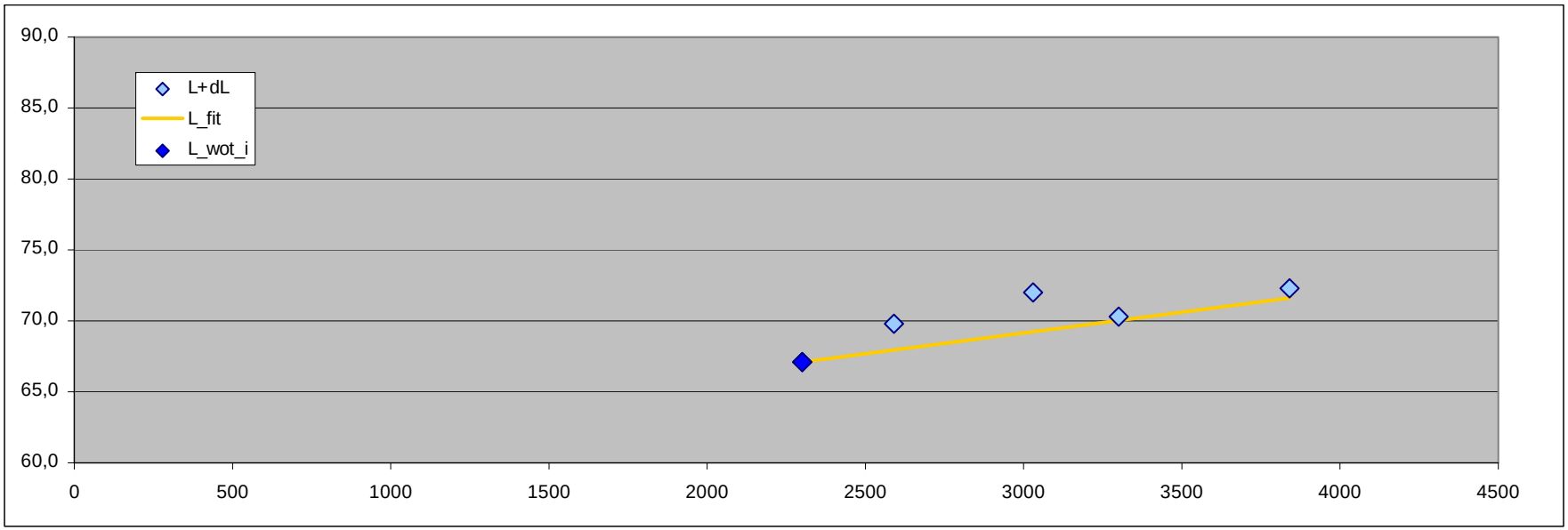
2300	Nbb_wot_i	67,1	Nbb_wot_i+1	0%	Reduction
	Lmax_i		Lmax_i+1	2,9	dB/1000rpm

Allowed Margin	
3	dB
-3	dB

Real Test DATA Example 1 / STEP 1

No	Nbb [1/min]	Measured L	dL	L+dL	dL/dN	L_fit	Delta
1	**2300**	**67,1**		**67,1**		**67,1**	0,0
3	2590	69,8	0,0	**69,8**	9,3	**67,9**	1,9
5	3030	72,0	0,0	**72,0**	5,0	**69,2**	2,8
7	3300	70,3	0,0	**70,3**	-6,3	**70,0**	0,3
9	3840	72,3	0,0	**72,3**	3,7	**71,6**	0,7

Step 1 o.k
Vehicle ASEP conform



Example 0205

2300	Nbb_wot_i		Nbb_wot_i+1
	Lmax_i		Lmax_i+1

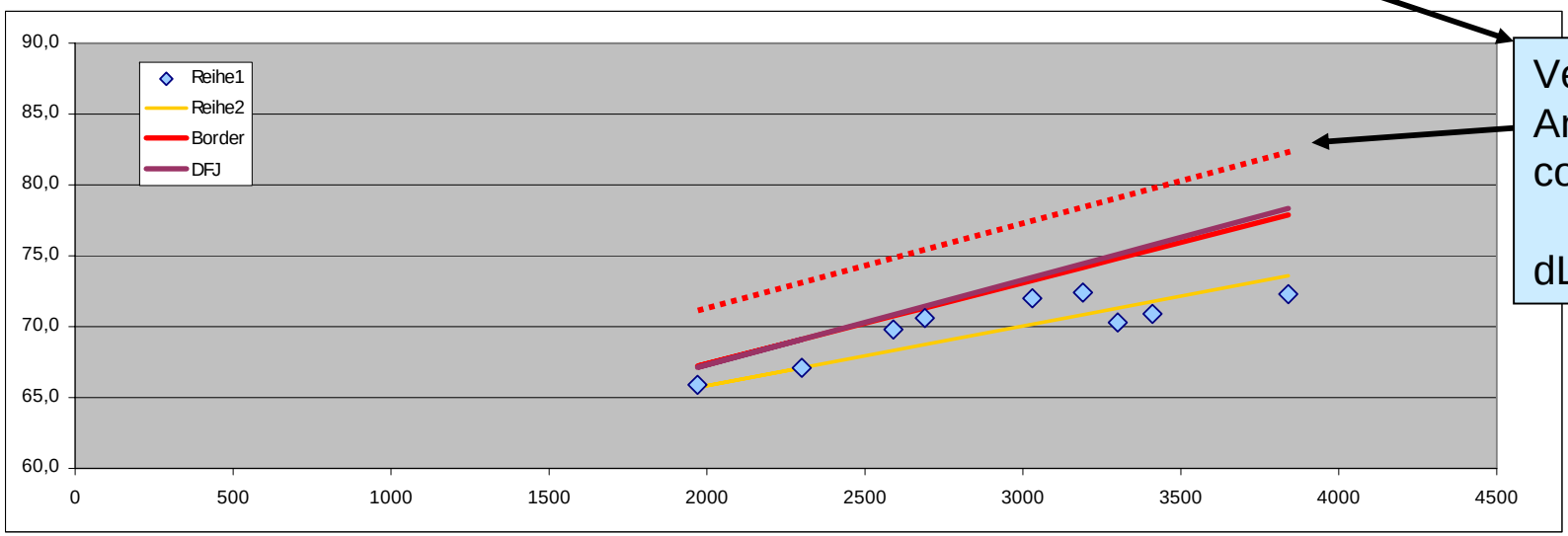
30%		
4,2	dB/1000rpm	

Margin	2,0	dB
Add Slope	1,5	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	5,7	dB/1000rpm

Real Test DATA Example 1 / STEP 2

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	**2300**	**67,1**		**67,1**		**67,1**	**69,1**	**69,1**	**-2,0**
2	1970	65,9	0,0	**65,9**	3,6	**65,7**	**67,2**	**67,1**	**-1,3**
3	2590	69,8	0,0	**69,8**	6,3	**68,3**	**70,8**	**70,8**	**-1,0**
4	2690	70,6	0,0	**70,6**	8,0	**68,7**	**71,3**	**71,4**	**-0,7**
5	3030	72,0	0,0	**72,0**	4,1	**70,2**	**73,3**	**73,5**	**-1,3**
6	3190	72,4	0,0	**72,4**	2,5	**70,8**	**74,2**	**74,4**	**-1,8**
7	3300	70,3	0,0	**70,3**	-19,1	**71,3**	**74,8**	**75,1**	**-4,5**
8	3410	70,9	0,0	**70,9**	5,5	**71,8**	**75,4**	**75,8**	**-4,5**
9	3840	72,3	0,0	**72,3**	3,3	**73,6**	**77,9**	**78,3**	**-5,6**

Step 2 o.k
Vehicle ASEP conform



Vehicle is very silent.
An additional margin could be applied:

$dLtype = L_{Limit} - L_{urban}$

Example 0711

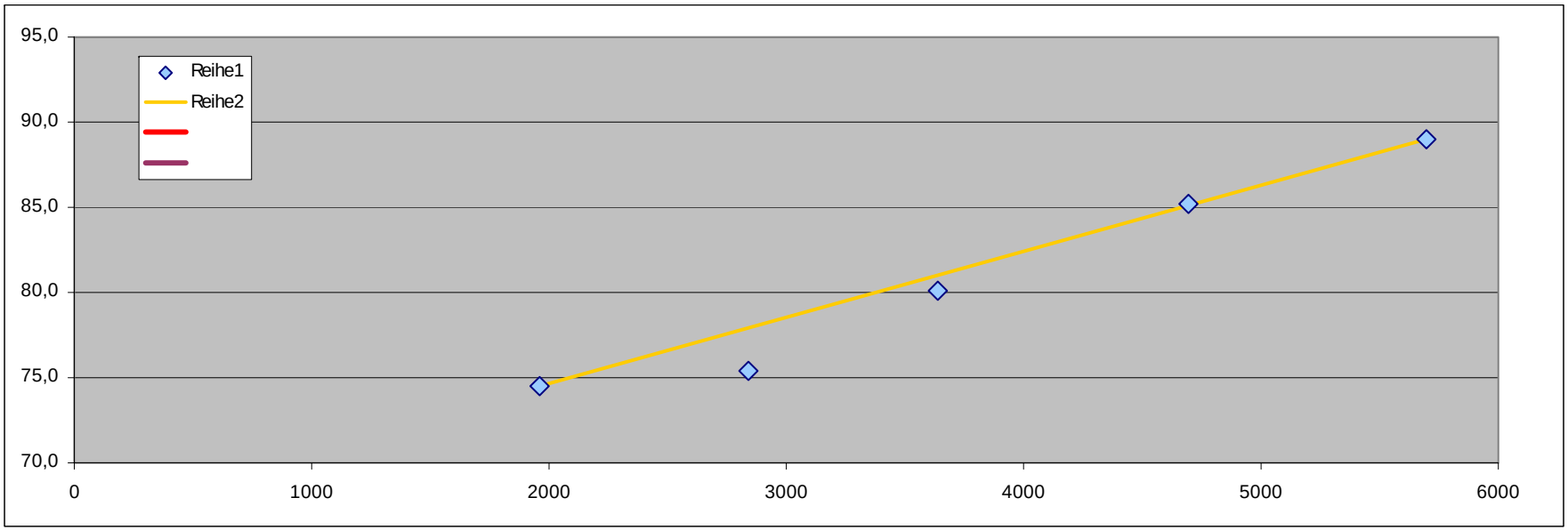
1960	Nbb_wot_i	**74,5**	Nbb_wot_i+1	**0%**	Reduction
	Lmax_i		Lmax_i+1	3,9	dB/1000rpm

Allowed Margin	
3	dB
-3	dB

Real Test DATA Example 2 / STEP 1

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Delta
1	**1960**	**74,5**		**74,5**		**74,5**	0,0
3	2840	75,4	0,0	**75,4**	1,0	**77,9**	-2,5
5	3638	80,1	0,0	**80,1**	5,9	**81,0**	-0,9
7	4695	85,2	0,0	**85,2**	4,8	**85,1**	0,1
9	5697	89,0	0,0	**89,0**	3,8	**89,0**	0,0

Step 1 o.k
Vehicle ASEP conform



Example 0711

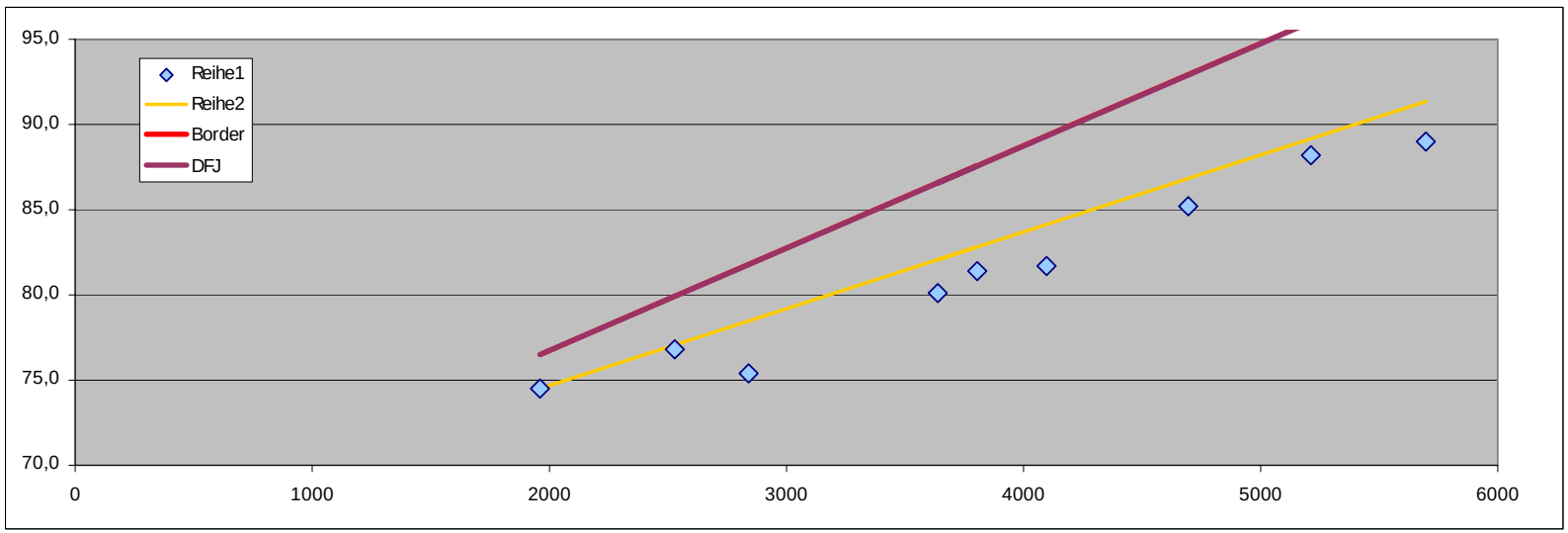
1960	Nbb_wot_i	74,5	Nbb_wot_i+1	30%	Reduction
	Lmax_i		Lmax_i+1	4,5	dB/1000rpm

Margin	2,0	dB
Add Slope	1,5	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	6,0	dB/1000rpm

Real Test DATA Example 2 / STEP 2

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	**1960**	**74,5**		**74,5**		**74,5**	**76,5**	**76,5**	**-2,0**
2	2529	76,8	0,0	**76,8**	4,0	**77,1**	**79,9**	**79,9**	**-3,1**
3	2840	75,4	0,0	**75,4**	-4,5	**78,5**	**81,8**	**81,8**	**-6,4**
4	3805	81,4	0,0	**81,4**	6,2	**82,8**	**87,6**	**87,6**	**-6,2**
5	3638	80,1	0,0	**80,1**	7,8	**82,1**	**86,6**	**86,6**	**-6,5**
6	4097	81,7	0,0	**81,7**	3,5	**84,1**	**89,3**	**89,3**	**-7,6**
7	4695	85,2	0,0	**85,2**	5,9	**86,8**	**92,9**	**92,9**	**-7,7**
8	5212	88,2	0,0	**88,2**	5,8	**89,2**	**96,0**	**96,0**	**-7,8**
9	5697	89,0	0,0	**89,0**	1,6	**91,3**	**99,0**	**98,9**	**-10,0**

Step 2 o.k
Vehicle ASEP conform



Real Test DATA
Example 3 / STEP 1

Vehicle 0103

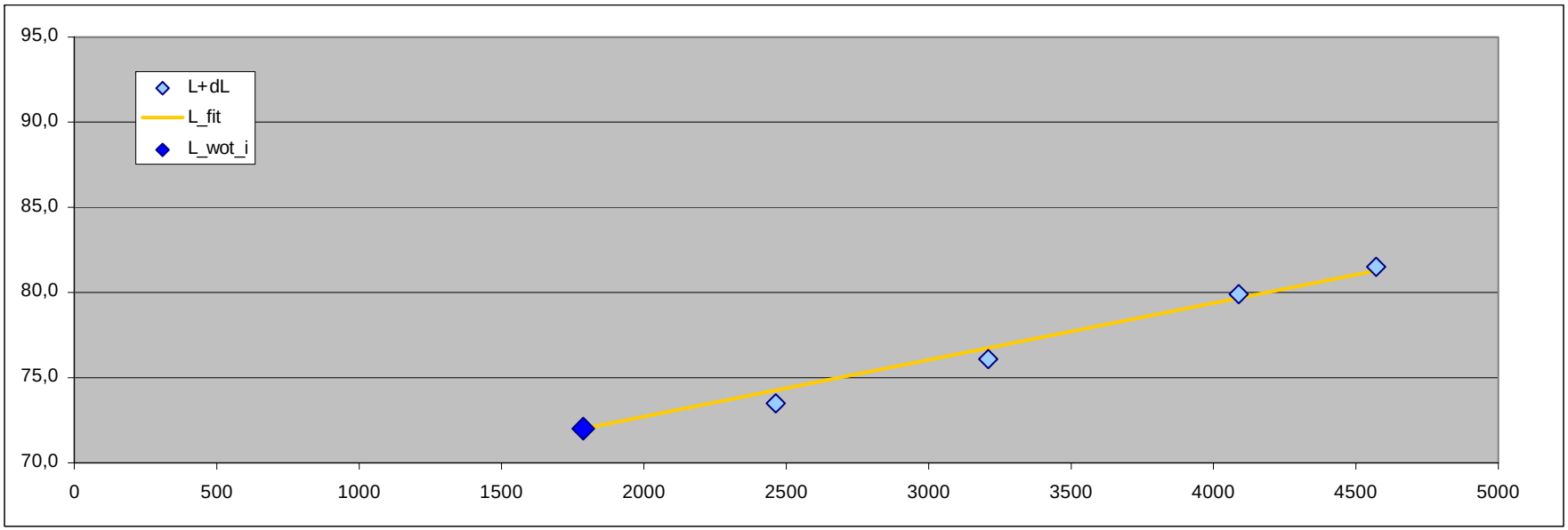
1787	Nbb_wot_i	72,0	Nbb_wot_i+1	0%	Reduction
	Lmax_i		Lmax_i+1	3,3	dB/1000rpm

Allowed Margin

3,0	dB
-3,0	dB

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Delta
1	**1787**	**72,0**		**72,0**		**72,0**	0,0
3	2463	73,5	0,0	**73,5**	2,2	**74,3**	-0,8
5	3209	76,1	0,0	**76,1**	3,5	**76,7**	-0,6
7	4089	79,9	0,0	**79,9**	4,3	**79,7**	0,2
9	4571	81,5	0,0	**81,5**	3,3	**81,3**	0,2

Step 1 o.k
Vehicle ASEP conform



Vehicle D-3

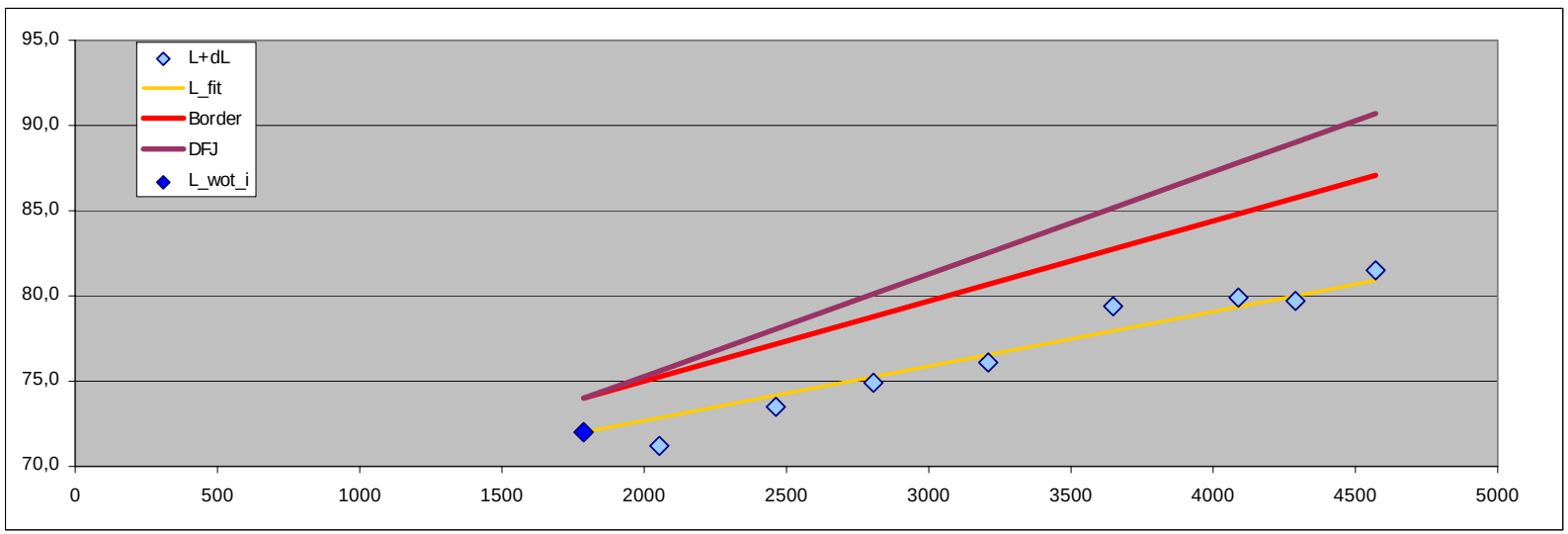
1787	Nbb_wot_i	72,0	Nbb_wot_i+1	30%	Reduction
	Lmax_i		Lmax_i+1	3,2	dB/1000rpm

Margin	2,0	dB
Add Slope	1,5	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	4,7	dB/1000rpm

Real Test DATA Example 3 / STEP 2

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	1787	72,0		72,0		72,0	74,0	74,0	-2,0
2	2053	71,2	0,0	71,2	-3,0	72,9	75,2	75,6	-4,0
3	2463	73,5	0,0	73,5	5,6	74,2	77,2	78,1	-3,7
4	2806	74,9	0,0	74,9	4,1	75,3	78,8	80,1	-3,9
5	3209	76,1	0,0	76,1	3,0	76,5	80,7	82,5	-4,6
6	3648	79,4	0,0	79,4	7,5	78,0	82,7	85,2	-3,3
7	4089	79,9	0,0	79,9	1,1	79,4	84,8	87,8	-4,9
8	4289	79,7	0,0	79,7	-1,0	80,0	85,8	89,0	-6,1
9	4571	81,5	0,0	81,5	6,4	80,9	87,1	90,7	-5,6

Step 2 o.k
Vehicle ASEP conform



Vehicle 0705 Tuner

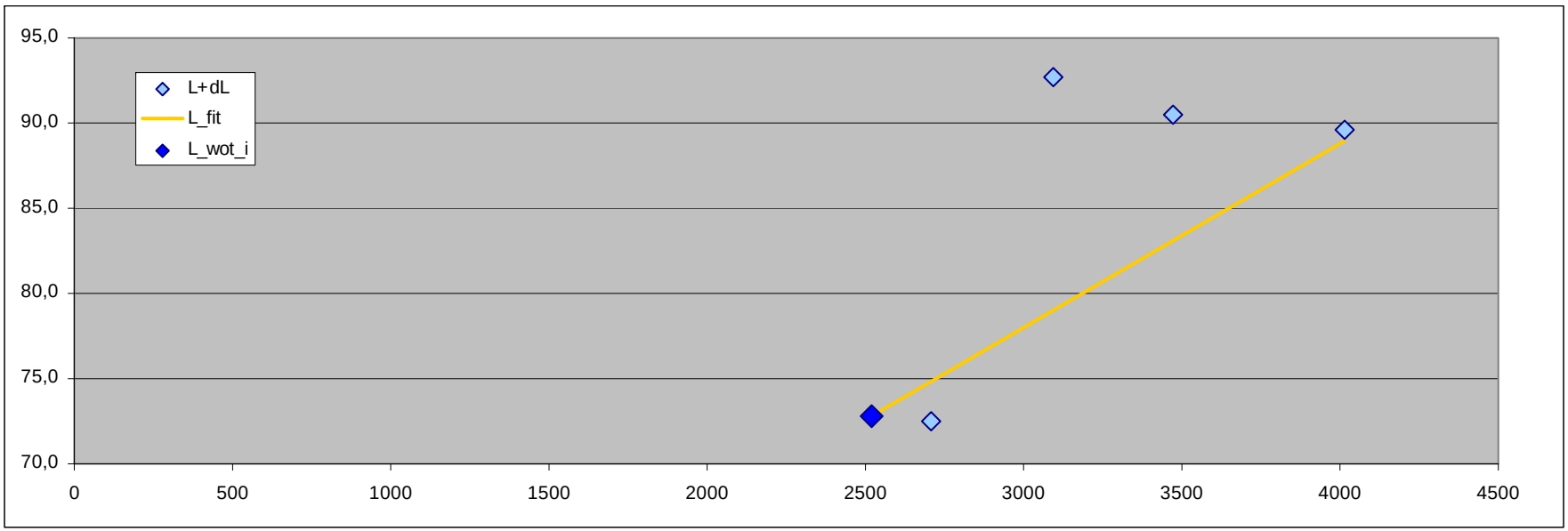
2520	Nbb_wot_i	72,8	Nbb_wot_i+1	0%	Reduction
	Lmax_i		Lmax_i+1	10,8	dB/1000rpm

Allowed Margin	
3,0	dB
-3,0	dB

Real Test DATA Example 4 / STEP 1

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Delta
1	**2520**	**72,8**		**72,8**		**72,8**	0,0
3	2708	72,5	0,0	**72,5**	-1,6	**74,8**	-2,3
5	3094	92,7	0,0	**92,7**	52,3	**79,0**	**13,7**
7	3472	90,5	0,0	**90,5**	-5,8	**83,1**	**7,4**
9	4014	89,6	0,0	**89,6**	-1,7	**89,0**	0,6

Step 1 failed
Step 2 required



Real Test DATA
Example 4 / STEP 2

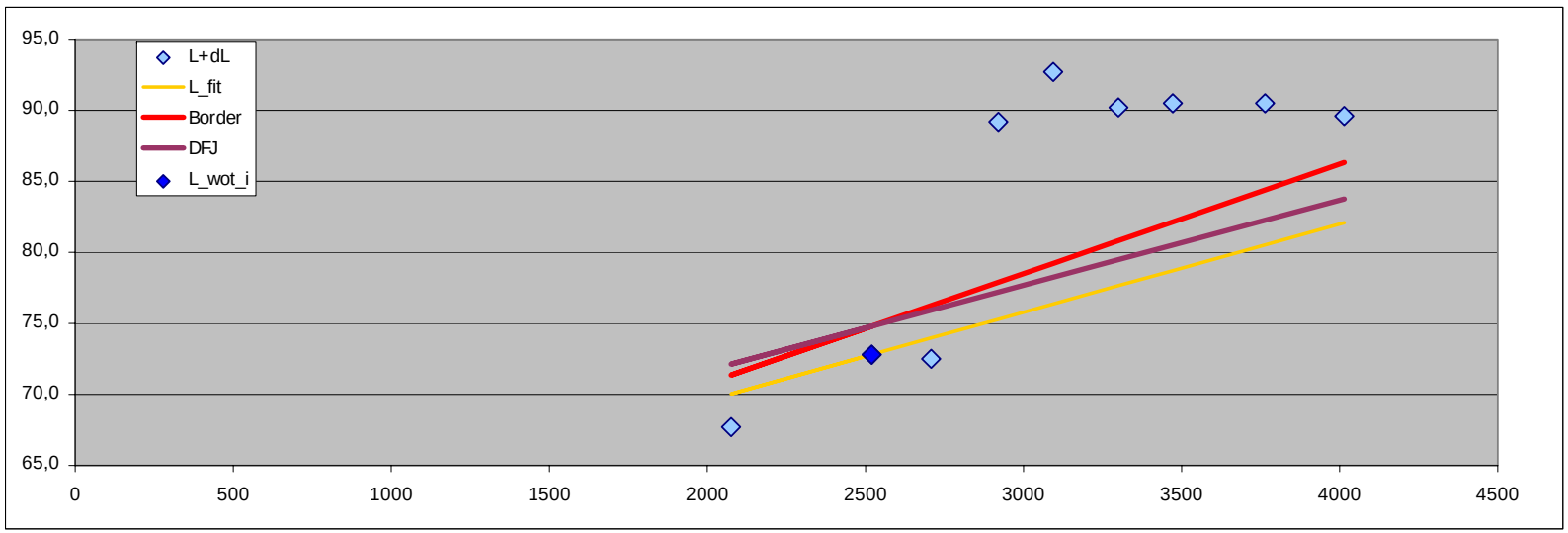
Vehicle 0705 Tuner

2520	Nbb_wot_i	72,8	Nbb_wot_i+1	30%	Reduction
	Lmax_i		Lmax_i+1	6,2	dB/1000rpm

Margin	2,0	dB
Add Slope	1,5	dB/1000rpm
Max. Slope	8,0	dB/1000rpm
Actual Slope	7,7	dB/1000rpm

No	Nbb [1/min]	L	dL	L+dL	dL/dN	L_fit	Border	DFJ	Delta
1	**2520**	**72,8**		**72,8**		**72,8**	**74,8**	**74,8**	**-2,0**
2	2075	67,7	0,0	**67,7**	11,5	**70,0**	**71,4**	**72,1**	**-3,7**
3	2708	72,5	0,0	**72,5**	7,6	**74,0**	**76,3**	**75,9**	**-3,8**
4	2920	89,2	0,0	**89,2**	78,8	**75,3**	**77,9**	**77,2**	**11,3**
5	3094	92,7	0,0	**92,7**	20,1	**76,4**	**79,2**	**78,2**	**13,5**
6	3300	90,2	0,0	**90,2**	-12,1	**77,6**	**80,8**	**79,5**	**9,4**
7	3472	90,5	0,0	**90,5**	1,7	**78,7**	**82,1**	**80,5**	**8,4**
8	3764	90,5	0,0	**90,5**	0,0	**80,5**	**84,4**	**82,3**	**6,1**
9	4014	89,6	0,0	**89,6**	-3,6	**82,1**	**86,3**	**83,8**	**3,3**

Step 2 failed
Vehicle NOT ASEP conform



MORE TEST RESULTS ARE AVAILABLE AND CAN BE SHOWN DURING THE PRESENTATION

- **Gear selection:**
  - **Manual transmission**
    - Test gear(s) mainly 2nd and 3rd gear (4th could be considered if $N_{bb\_wot\_i}$ is very low)
    - Limitation of acceleration must be considered because:
      - Driveability (Spinning wheels, specially for front engine vehicles)
      - Representatives for real driving
      - Similarity to 1st gear driving
  - **Automatic transmission**
    - Examples show, that test in D-mode is feasible, but might lead to lack of information in a certain engine speed range.
    - Test should be carried out on a vehicle speed base (e.g. from 20 to 60 km/h).
    - Speeds higher than 60 km/h will not provide more information, because the highest engine speeds will be reached in lower driving speed, due to downshift to 2nd gear.
    - Results should be reported over engine speed.
    - Conflicts must be faced to the fact, that the status of the torque converter is unknown.
    - More test data are needed to fill the gap of information.