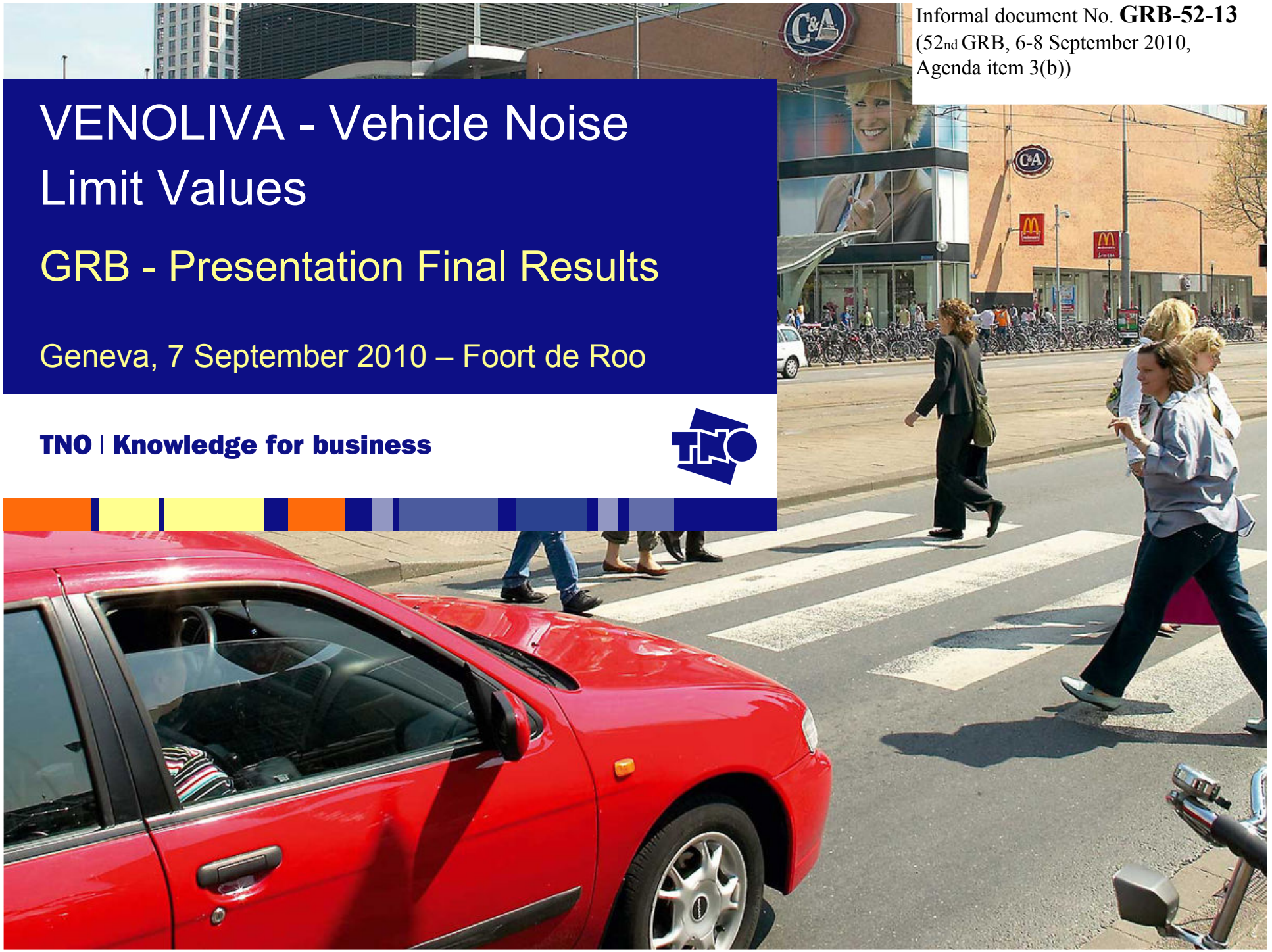
Informal document No. **GRB-52-13**
(52nd GRB, 6-8 September 2010,
Agenda item 3(b))

VENOLIVA - Vehicle Noise Limit Values

GRB - Presentation Final Results

Geneva, 7 September 2010 – Foort de Roo

TNO | Knowledge for business



Introduction

Vehicle noise type approval test methods:

- Current method A – Regulation 51 – Addendum 50 – Annex 3
- New method B – Regulation 51 – Addendum 50 – Annex 10

Monitoring period of method B – parallel testing:

- UN-ECE: 01-07-2007 / 01-07-2009
- EU: 06-07-2008 / 06-07-2010

Test data submitted to European Commission

→Stored in Circa web-site database

→VENOLIVA project 1st goal: analysis of database

Questions to be answered by this study

- How to change limit values if method B is implemented?
- How to deal with current allowances for special vehicles?
- What is environmental, social and economic impact of implementation of method B + limit values?
- What is assessment of effectiveness of method B?
- Which modifications to method B are recommended?
- How can off-cycle noise emission be controlled?

Topics in the presentation

- Final contents of database
- Results of data analysis
- Relevance of allowances
- Policy options – proposed limit value changes
- Evaluation of method B
- Off-cycle emission provisions

- Impact analysis → presentation Michael Dittrich

- Conclusions & recommendation

Circa database - contents

- Final analysis based on contents database 07-07-2010

Vehicle Category	Informal category description (see 2007/46/EC – Annex II)	Files in Circa database	Converted single vehicle files	Analysed single vehicles Files
M1	Passenger car	670	660	653
M1G	Passenger car for off-road use	-	26	24
M2	Medium sized bus	3	28	28
M3	Heavy bus	56	76	76
N1	Small van	51	52	52
N1G	Small van for off-road use	-	3	3
N2	Medium sized van / lorry	34	58	55
N3	Heavy truck	179	118	100
N3G	Heavy truck for off-road use	-	39	39
	Files / data not usable	36	4	34
Total		**1029**	**1064**	**1064**

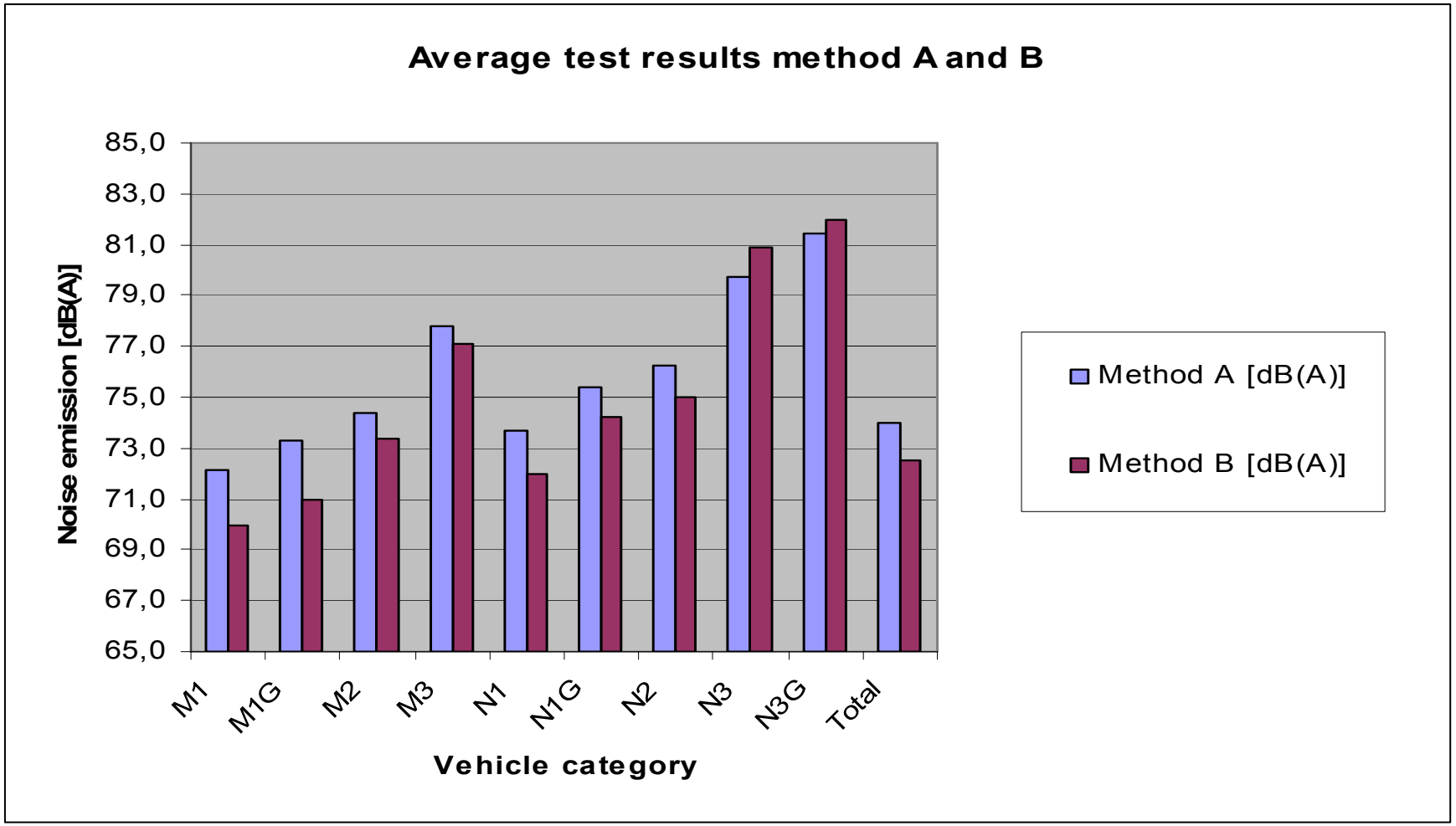
Circa database – Results (1)

- Noise emission according to method A and method B

Vehicle category	Description	Number of vehicles	Average test results		Difference B – A [dB(A)]
			Method A [dB(A)]	Method B [dB(A)]	
M1	Passenger car	653	72,1	70,0	-2,1
M1G	Pass. car -off-road	24	73,3	71,0	-2,3
M2	Medium sized bus	28	74,4	73,4	-1,0
M3	Heavy bus	76	77,8	77,1	-0,7
N1	Van	52	73,7	72,0	-1,7
N1G	Van – off-road	3	75,4	74,2	-1,2
N2	Medium sized truck	55	76,3	75,0	-1,2
N3	Heavy truck	100	79,7	80,9	1,2
N3G	Heavy truck – off-road	39	81,4	82,0	0,6
Total		1030	74,0	72,5	-1,5

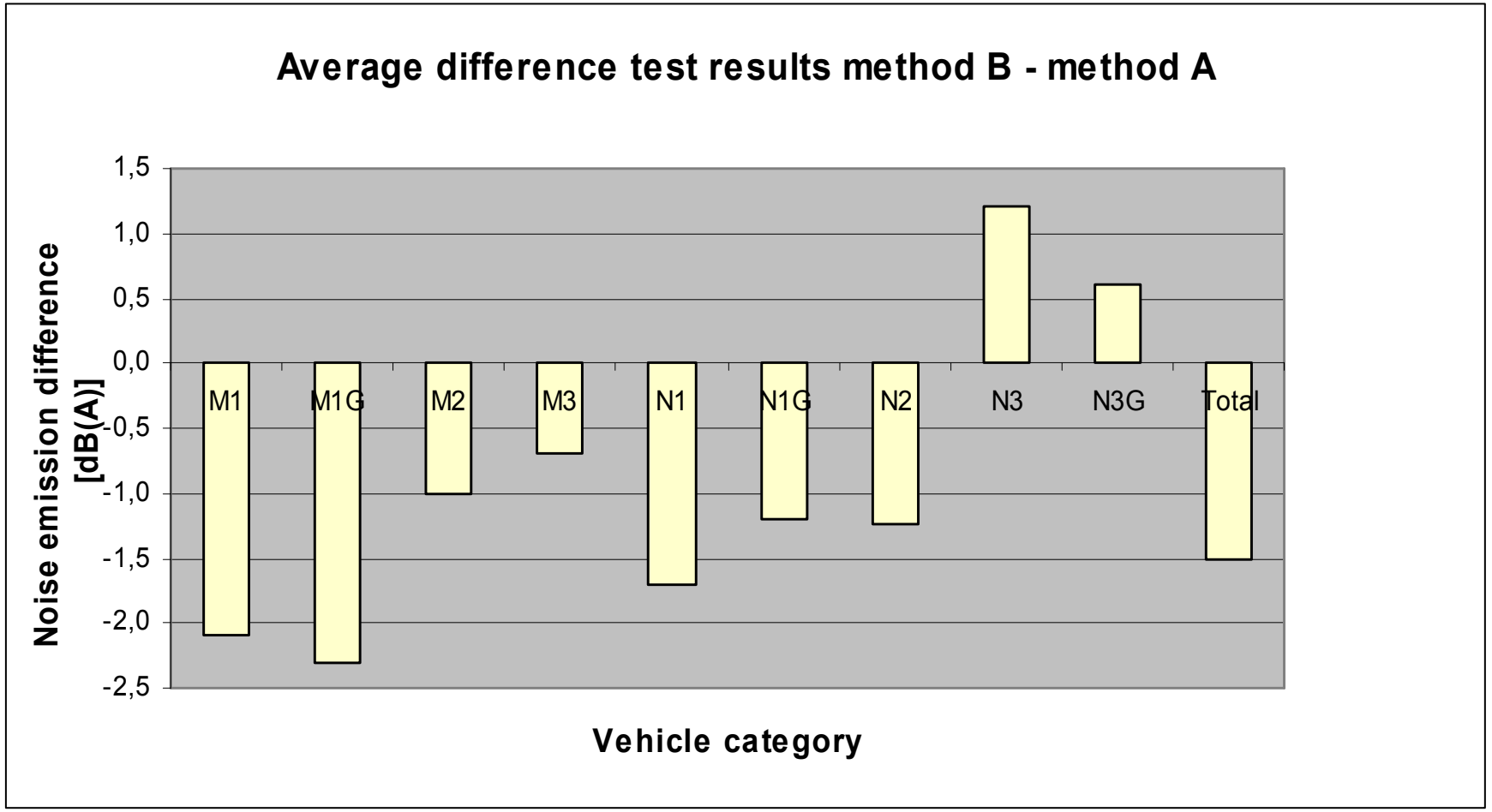
Circa database – Results (2)

- Noise emission according to method A and method B



Circa database – Results (3)

- Noise emission according to method A and method B



Circa database – Results (4)

- Influence of engine type & gearbox type

Vehicle Category	Test results method A [dB(A)]		Test results method B [dB(A)]		Test results method A [dB(A)]			Test results method B [dB(A)]		
	Engine type		Engine type		Gearbox type			Gearbox type		
	Petrol	Diesel	Petrol	Diesel	Manual	Automatic	CVT	Manual	Automatic	CVT
M1	72,3	71,7	70,3	69,6	72,4	71,4	69,9	69,9	70,3	69,2
M1 number	389	269	389	269	434	218	6	434	218	6
M1G	72,1	73,9	70,9	71,1	74,7	72,1		70,5	71,4	
M1G number	8	16	8	16	11	13		11	13	
M2	72,0	74,5	72,0	73,4	74,7	73,2		72,7	75,9	
M3	77,1	77,9	76,8	77,2	78,9	77,3	81,0	77,3	77,0	76,6
N1	72,7	74,0	71,2	72,2	74,1	72,3		71,8	72,9	
N1 number	9	43	9	43	42	10		42	10	
N1G		75,4		74,2	77,1	72,0		75,0	72,6	
N2		76,3		75,0	77,0	73,6		75,4	73,8	
N3		79,7		80,9	80,0	79,5		80,4	81,2	
N3G		81,4		82,0	81,4	81,3		81,8	83,1	

Circa database – Results (5)

No significant influence on noise emission (method A or B) of:

- Cylinder capacity
- Engine power
- Power to mass ratio (PMR)

Explanation:

- Test method A: high powered cars adapted test method
  → WOT-test only in 3rd gear
- Test method B: WOT-test in higher gears for higher PMR
  → lower engine speed at 50 km/h → relatively lower noise emission

Allowances – relevance & justification (1)

Allowance of 1 dB(A) for direct-injection Diesel engines

- M1 – passenger cars: only DI Diesels
- Difference Diesel – Petrol: Method A: – 0,6 dB(A)
  Method B: – 0,7 dB(A)
- M1G Off-road passenger cars
  → difference Diesel – Petrol: A: + 1,8 dB(A)
  B: + 0,2 dB(A)
- N1 - Vans
  → difference Diesel – Petrol: A: + 0,9 dB(A)
  B: + 1,0 dB(A)
- But: 43 Diesel vehicles vs. 4 Petrol and 5 Gas vehicles

Conclusion: Allowance no longer relevant

Allowances – relevance & justification (2)

Allowance of 1 or 2 dB(A) for off-road vehicles

- Difference M1G – M1: method A: +1,2 dB(A)
  method B: +1,0 dB(A)
- Difference N1G – N1: method A: +1,7 dB(A)
  (number N1G = 3) method B: +2,2 dB(A)
- Difference N3G – N3: method A: +1,7 dB(A)
  method B: +1,1 dB(A)

Conclusions:

- Under test method B allowance of 1 dB(A) justified
- Only for vehicles that fulfil off-road criteria
  (Dir 2007/46/EC – Annex II – Art. 4)
- No evidence for 2 dB(A) allowance for all vehicles with engine power > 150 kW
- For N3G vehicles with engine power > 150 kW allowance of 2 dB(A) justified based on difference B-A

Allowances – relevance & justification (3)

Allowance of 1 dB(A) for High Powered cars (M1) – Criteria:

- Number of gears > 4
- Engine power > 140 kW
- Power to Mass Ratio > 75 kW/t
- Speed at line BB' > 61 km/h

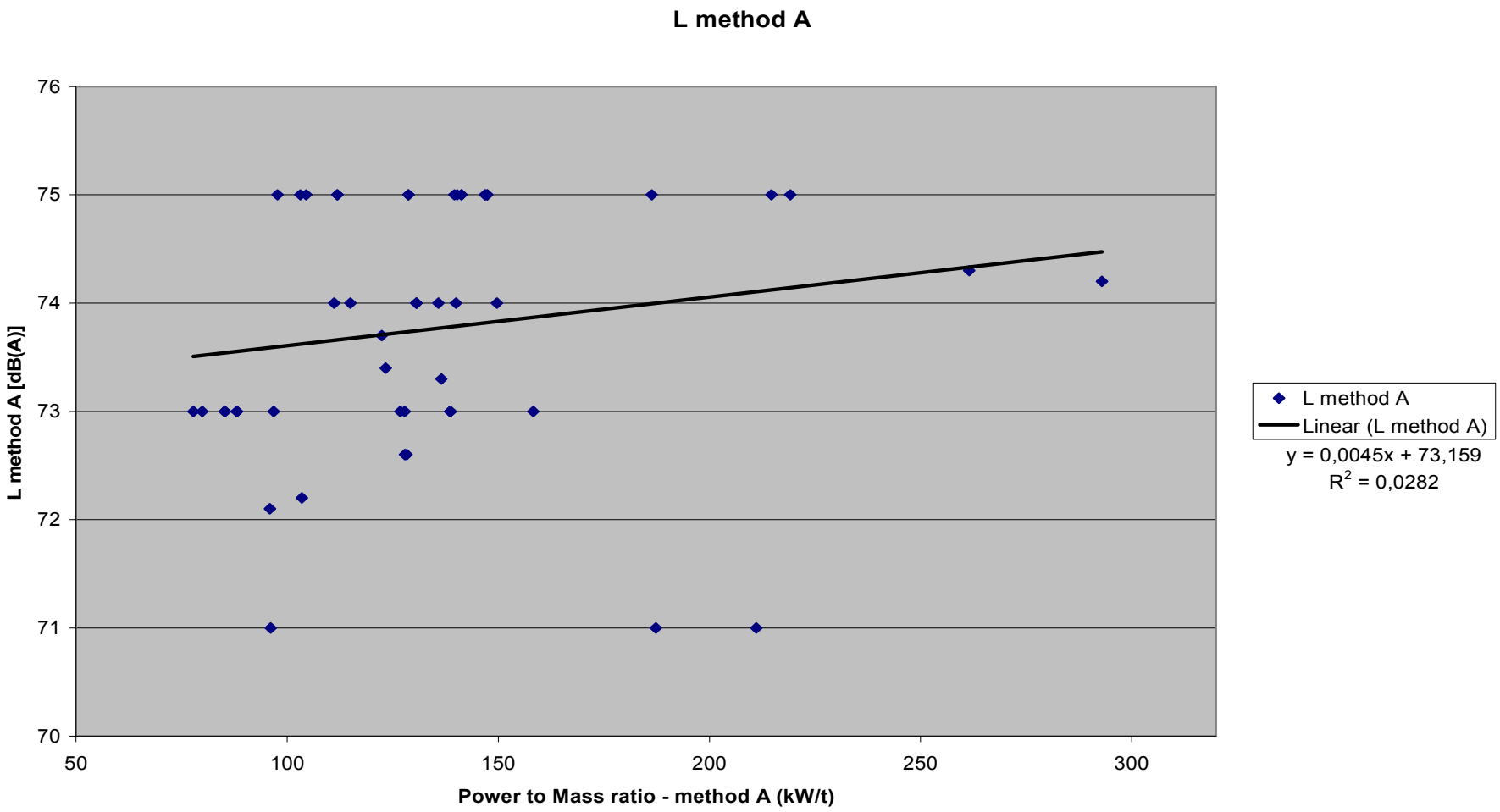
50 vehicles fulfilled criteria

Difference High Powered cars – Normal cars:

- Method A: + 1,7 dB(A) (HP cars in 3rd gear only)
- Method B: + 0,8 dB(A)

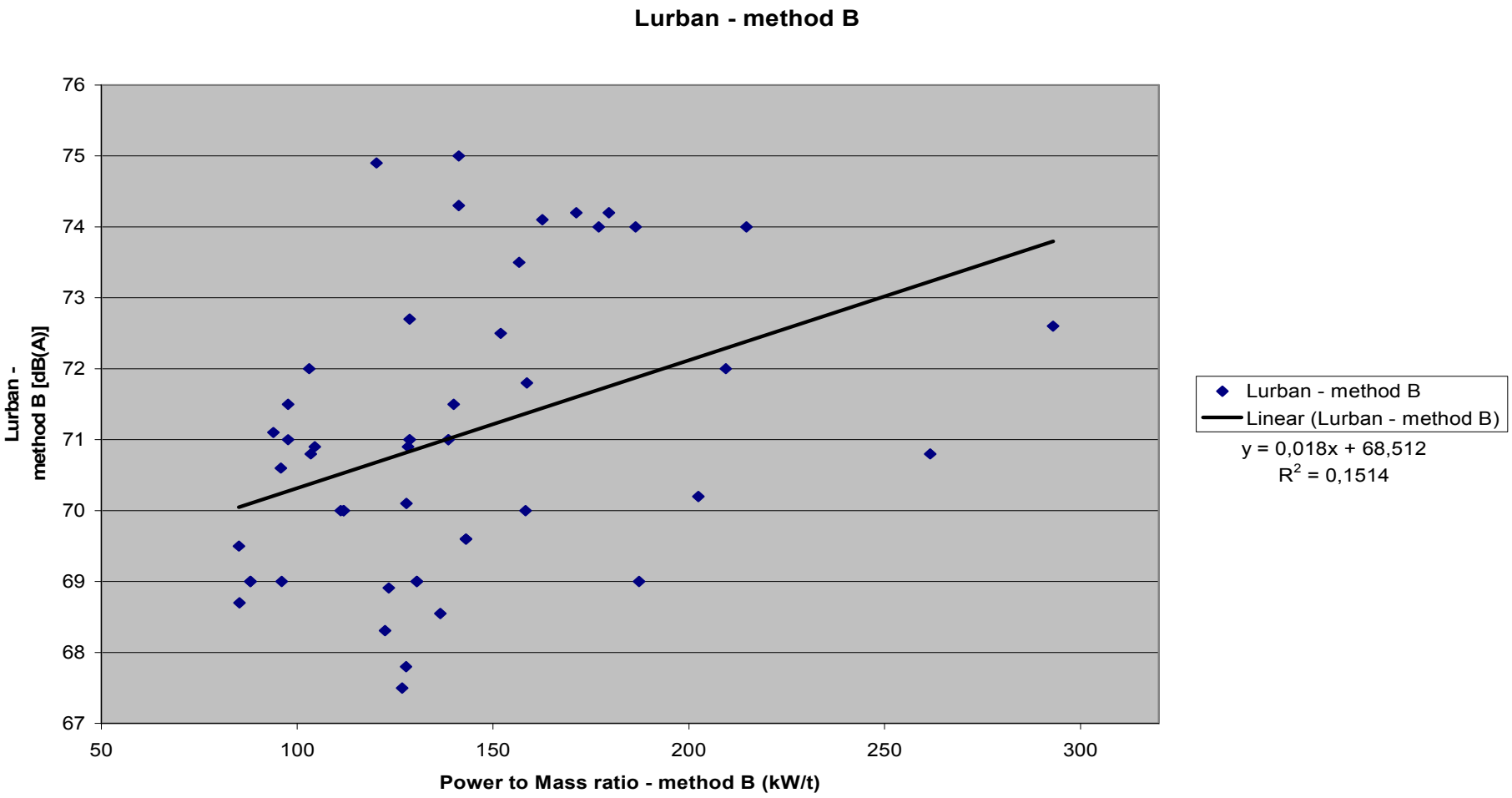
Allowances – relevance & justification (4)

HP cars - Influence of Power to Mass ratio on noise emission method A



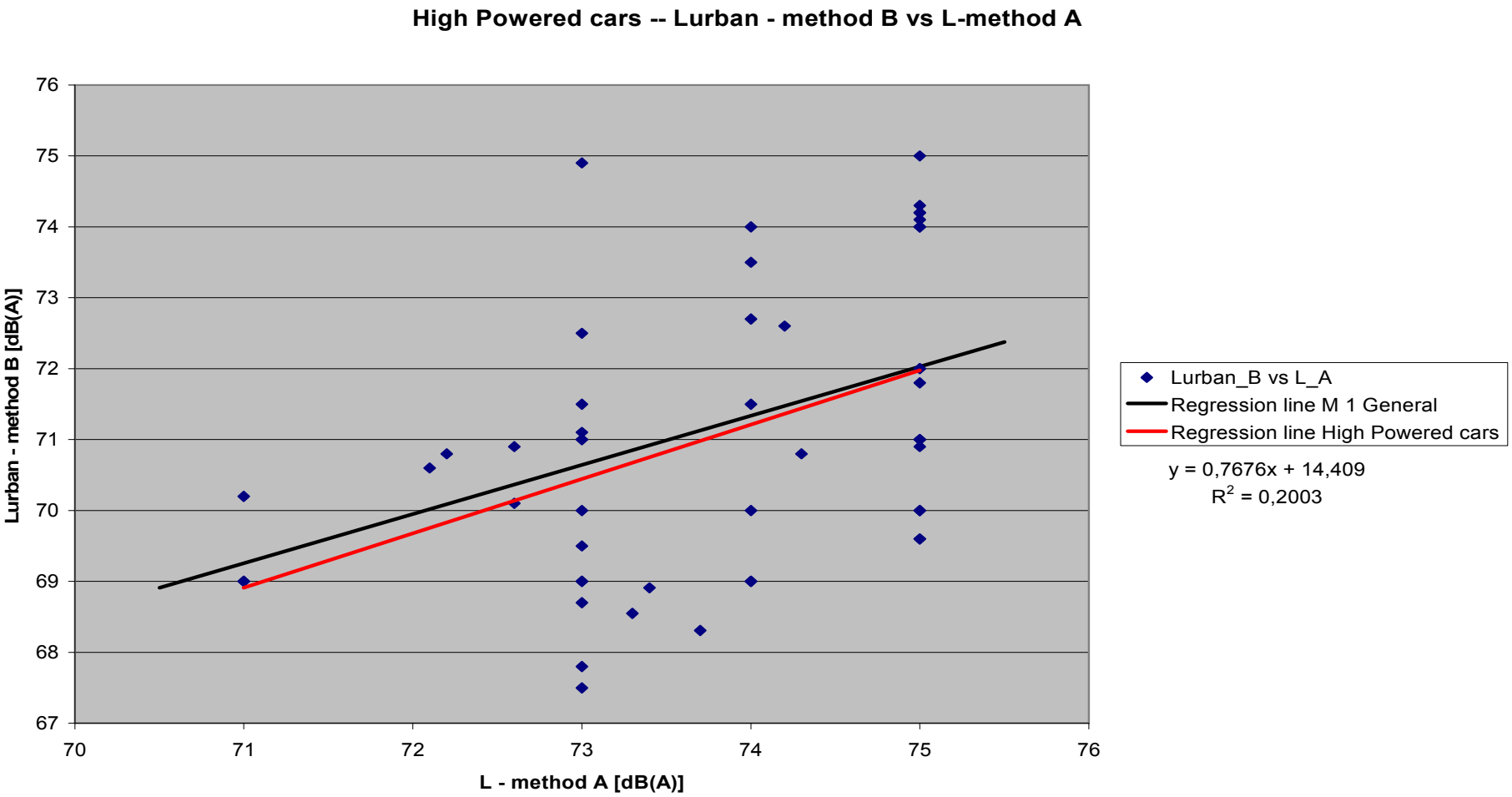
Allowances – relevance & justification (5)

HP cars - Influence of Power to Mass ratio on noise emission method B



Allowances – relevance & justification (6)

HP cars – Results of method B as a function of results of method A



Allowances – relevance & justification (7)

- Noise emission of high powered cars is higher than other cars
- Increasing number of vehicles fulfils criteria

Conclusion:

- Allowance of 1 dB(A) is justified
- Proposed adaptation of criteria:
  - Power to Mass Ratio > 150 kW/t

Change of Limit Values – Policy Options

Five Policy Options:

1. No change: test method A; current limit values;
2. Test method B with current limit values;
3. Test method B with new limit values, equivalent to current situation;
4. Test method B with reduced limit values, aiming at noise reduction per motor vehicle
5. Test method B with reduced limit values, aiming at noise reduction per motor vehicle; in 2 step approach

Policy Options – elaboration (1)

- Option 1 – No change

- Option 2 – Test method B; current limit values;
  Allowances: off-road 1 dB(A)
  HP cars 1 dB(A)

- Option 3 – Test method B; new / equivalent limit values
  - Derivation equivalent limit values by 3 methods:
    - Regression equation result B as function of result A
    - Average difference between result B – result A
    - Distribution of results A and B → percentage non-compliant vehicles

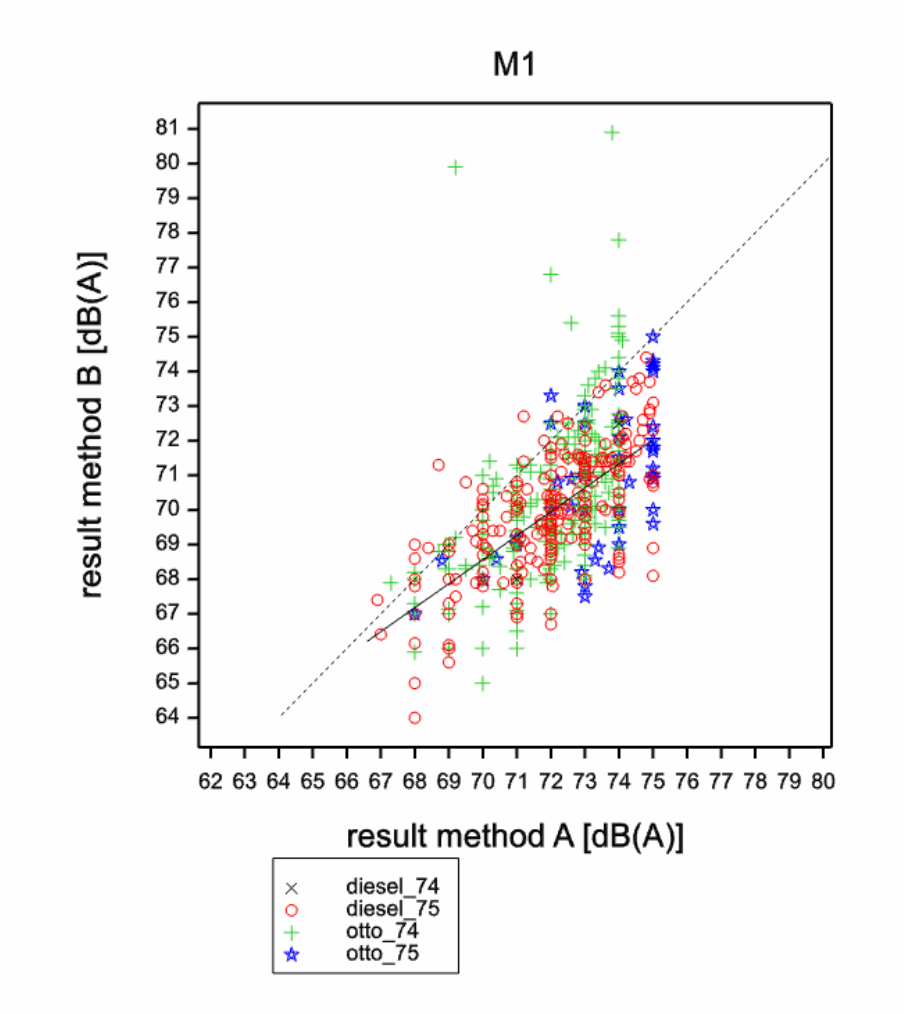
Policy Options – elaboration (2)

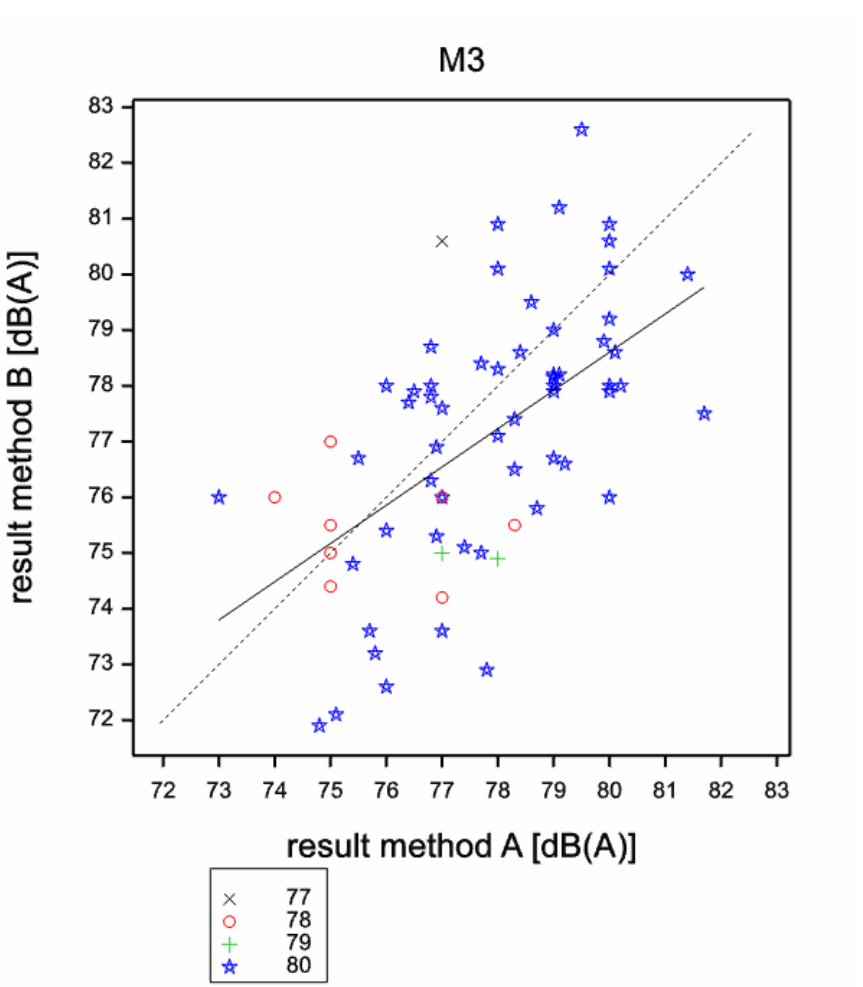
- Regression equation → Result B = a + s•result A

	Regression line		Limit values for current method [dB(A)]						
Vehicle category	**Intercept *a***	**Slope *s***	**74**	**75**	**76**	**77**	**78**	**79**	**80**
			Estimated limit values for new method [dB(A)]						
M1	20,07	0,693	71,3	72,0					
M1G		Not signft							
M2		Not signft							
M3	23,66	0,687					77,2	77,9	78,6
N1	34,86	0,504		72,7	73,2	73,7	74,2	74,7	
N2	9,90	0,854				75,6	76,5	77,4	78,2
N3		Not signft							
N3G		Not signft							

Policy Options – elaboration (3)

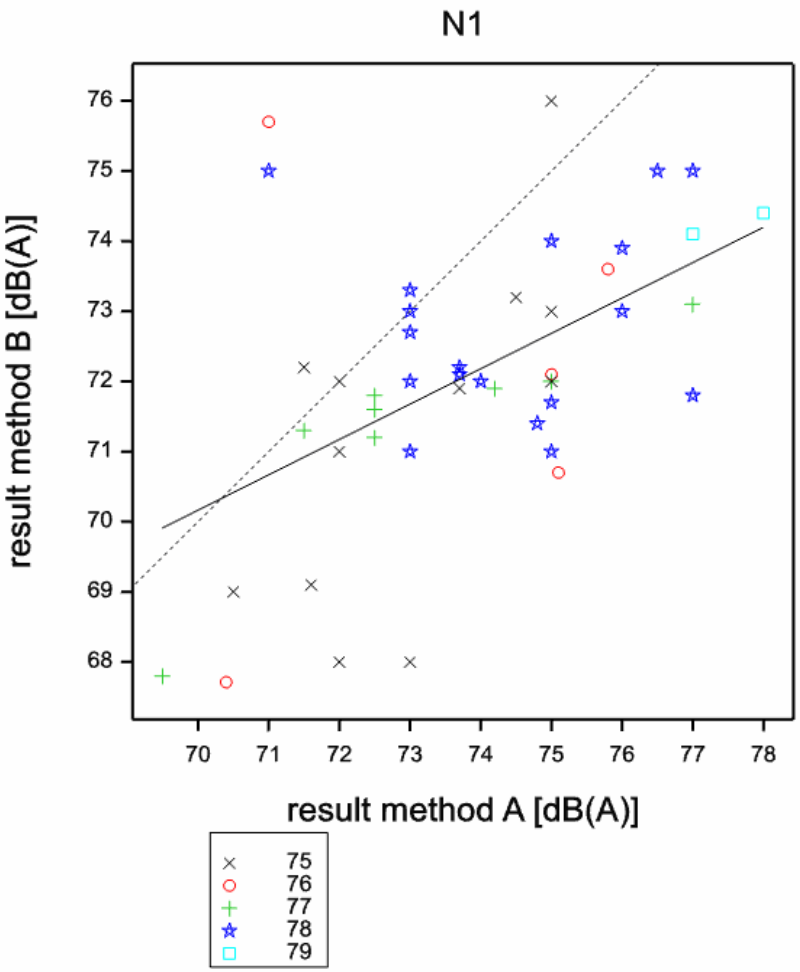
- Regression

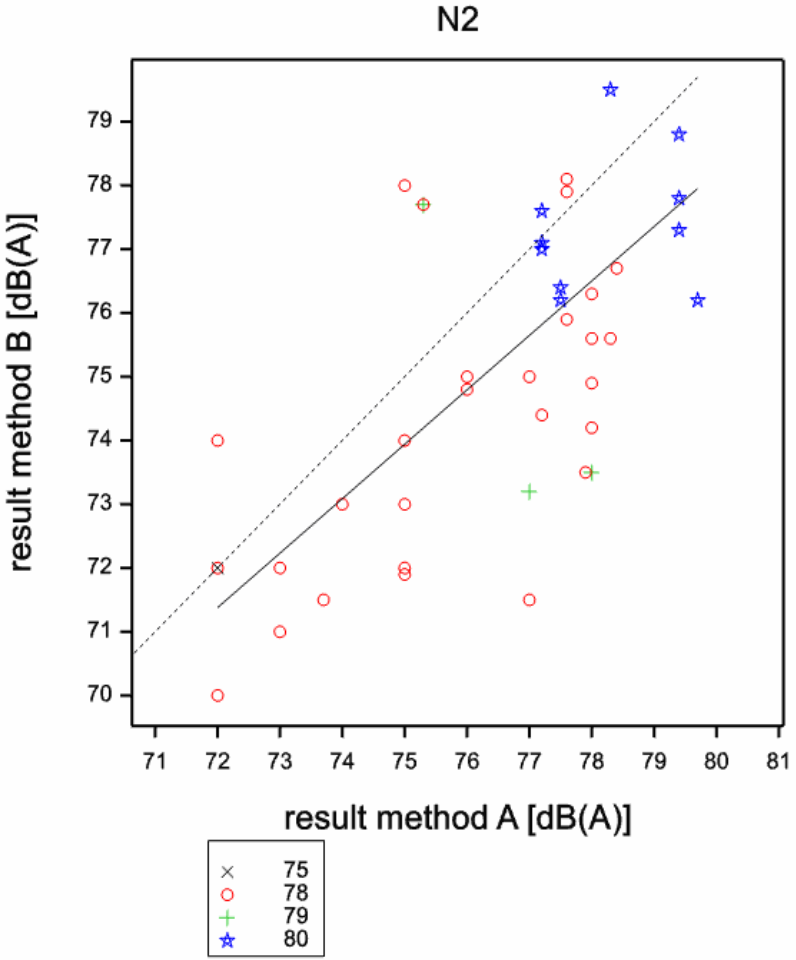




Policy Options – elaboration (4)

- Regression





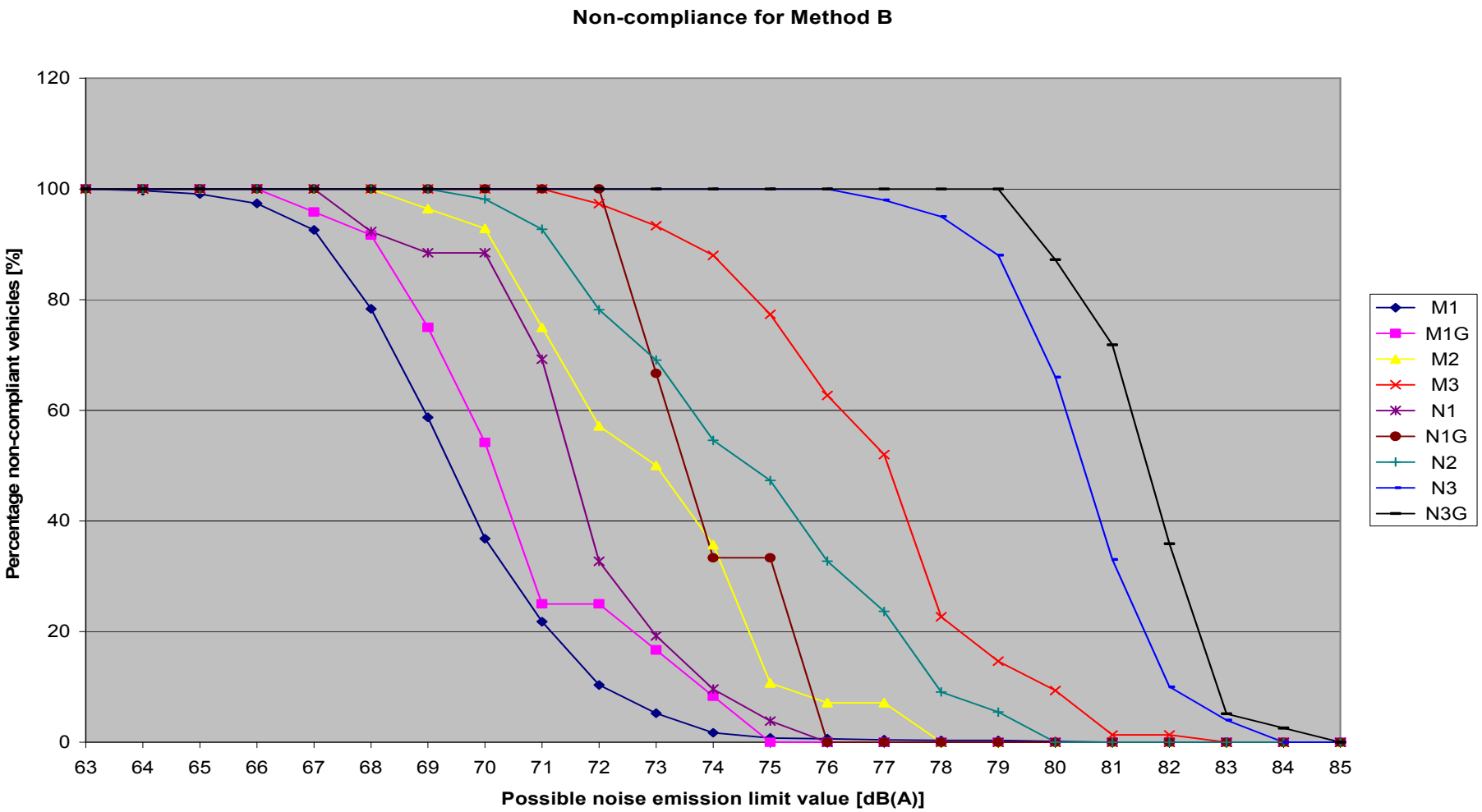
Policy Options – elaboration (5)

- Average difference between result B – result A

		Limit values acc. current method [dB(A)]							
Vehicle category	**B - A mean**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**82**
	[dB(A)]	**Estimated limit values for new method [dB(A)]**							
M1	-2,1	71,9	72,9						
M1G	-2,3	71,7	72,7	73,7	74,7				
M2	-1,0			75,0	76,0	77,0	78,0	79,0	
M3	-0,7					77,3	78,3	79,3	
N1	-1,7	72,3	73,3	74,3	75,3	76,3			
N1G	-1,2								
N2	-1,2				75,8	76,8	77,8	78,8	
N3	1,2					79,2	80,2	81,2	83,2
N3G	0,6					78,6	79,6	80,6	82,6

Policy Options – elaboration (6)

- Percentage of non-compliant vehicles



Policy Options – elaboration (7)

- Option 4 – Test method B; new reduced limit values
  - EU Regulation No. 661/2009 → average reduction limit values for rolling noise 3,8 dB(A) (Cars) / 3,3 dB(A) (Trucks)
  - From 1 November 2012 (new tyres types)
  - From 1 November 2013 (new vehicle types)
  - From 1 November 2016 (all new tyres and vehicles)
  - Estimated effect average rolling noise 3,3 – 3,8 dB(A)
  - Estimated effect cruise test Lcrs-rep 2,1 – 2,4 dB(A)
  - Estimated effect type test result light vehicles 1,3 – 1,7 dB(A)

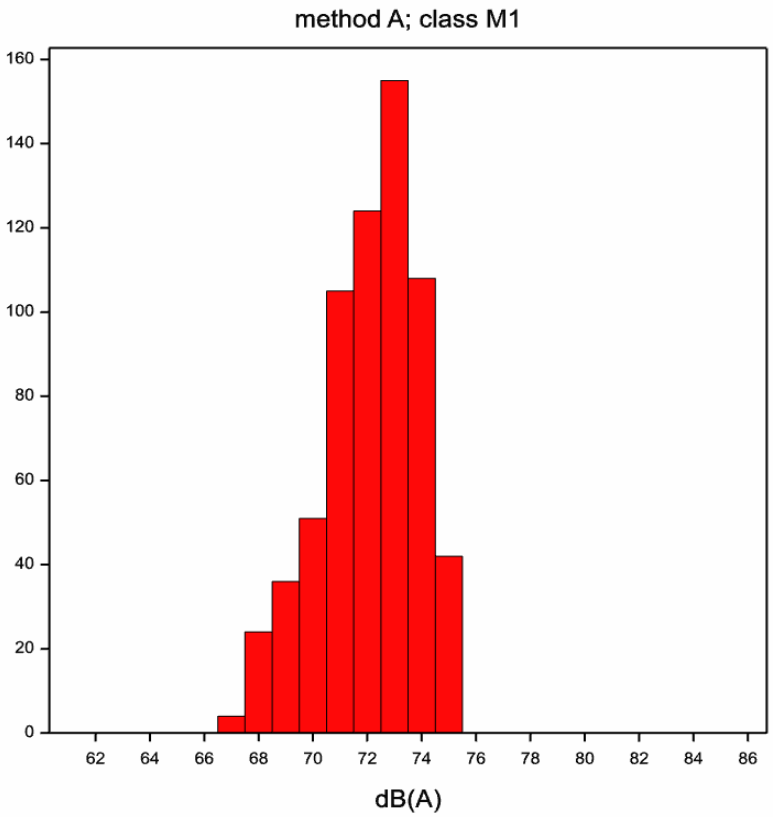
Policy Options – elaboration (8)

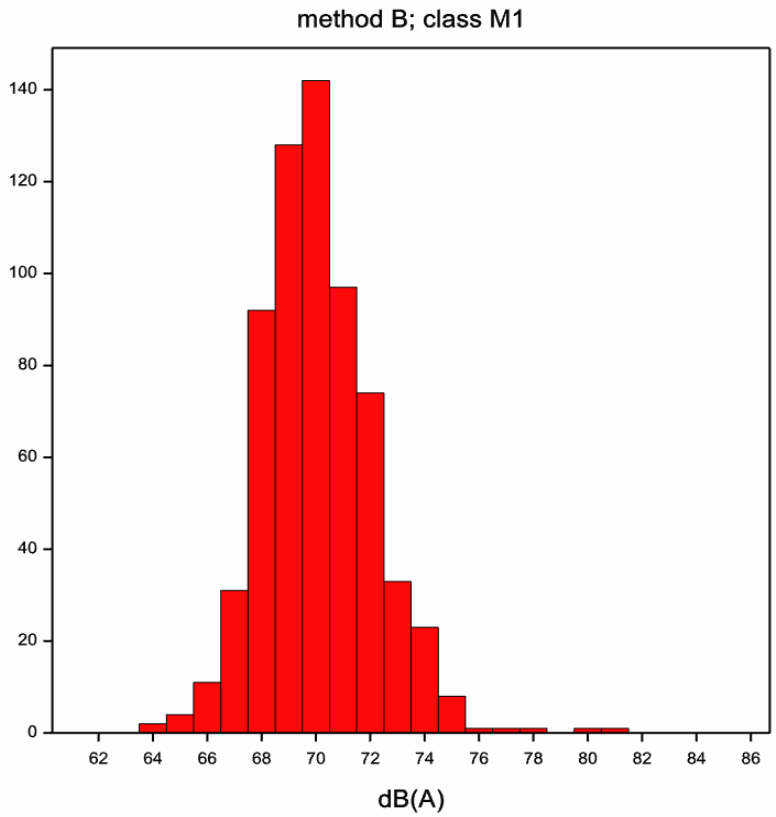
- Option 4 – Proposed reduction of limit values:

		Light vehicles	Heavy vehicles	Implementation date
1st stage	New types	- 3 dB(A)	- 2 dB(A)	1 January 2014
2nd stage	All vehicles	- 3 dB(A)	- 2 dB(A)	1 January 2016

Policy Options – elaboration (9)

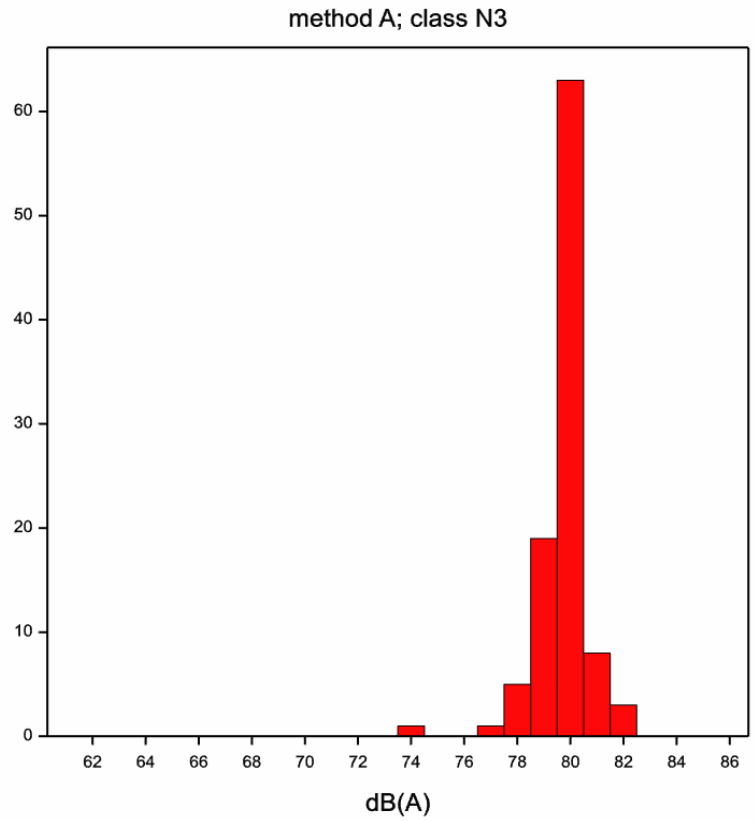
Consequences of limit value reduction for percentage compliance for passenger cars

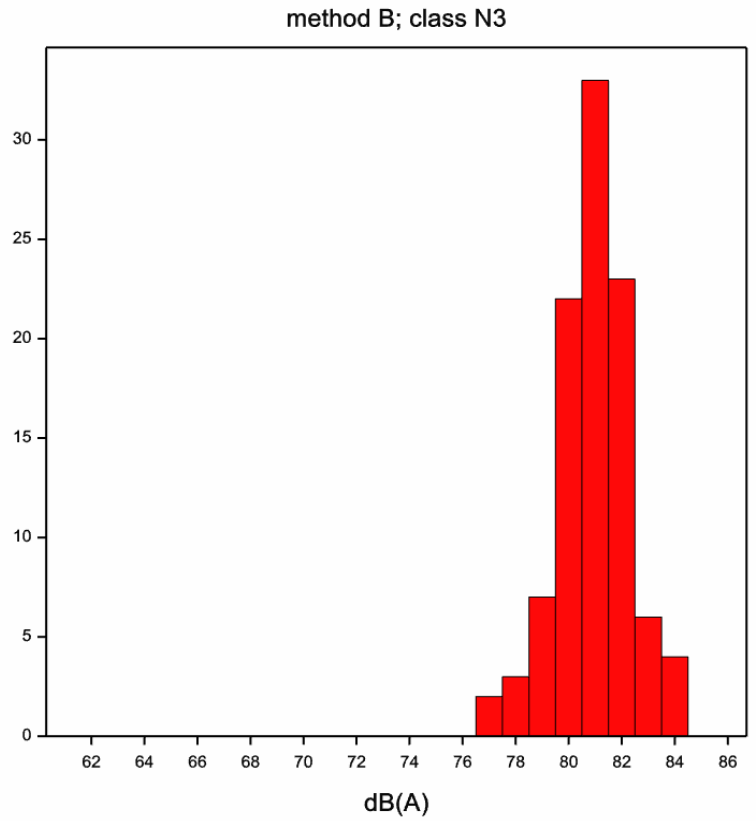




Policy Options – elaboration (10)

Consequences of limit value reduction for percentage compliance for heavy trucks





Policy Options – elaboration (11)

- Option 5 - Test method B; new reduced limit values in 2 steps

  - Effect of EU Regulation No. 661/2009 → Estimated effect on type test result light vehicles 1,3 – 1,7 dB(A)
  - First step reduction of limit values mainly based on rolling noise reduction
  - Second step will require power train noise reduction for
    > 50% of the vehicles
  - Some vehicles comply with reduced limit values already now
    → reduced limit values are considered feasible

Policy Options – elaboration (12)

- Option 5 – Proposed reduction of limit values:

		Light vehicles	Heavy vehicles	Implementation date
1st stage	New types	- 2 dB(A)	- 1 dB(A)	1 January 2013
2nd stage	New types	- 2 dB(A)	- 2 dB(A)	1 January 2015
3rd stage	All vehicles	- 4 dB(A)	- 3 dB(A)	1 January 2017

Section (Reg. 51; Addendum 50; Rev 1)	Vehicle cate-gory	Description	Extra allowance option				No in data-base	Limit value Option 1	Limit value Option 2	Limit value Option 3	Limit value Option 4	Limit value Option 5	
			6.2.2.2.1	6.2.2.2.3	6.2.2.2.2.1	6.2.2.2.2.2							
			Direct-injection Diesel engine	High powered cars	Off-road; mass > 2t; power < 150 kW	Off-road; mass > 2t; power > 150 kW						1st step	2nd step
			1 dB(A)	1 dB(A)	1 dB(A)	2 dB(A)							
6.2.2.1.1	M1	Passenger car					332	74	74	72	69	70	68
6.2.2.1.1	M1	Passenger car	X				269	75	~~75~~	~~72~~			
6.2.2.1.1	M1	Passenger car		X			51	75	75	73	70	71	69
6.2.2.1.1	M1G	Passenger car - off-road			X		12	75	75	73	70	71	69
6.2.2.1.1	M1G	Passenger car - off-road				X		76	~~76~~	~~73~~			
6.2.2.1.1	M1G	Passenger car - off-road	X		X		7	76	~~76~~	~~73~~			
6.2.2.1.1	M1G	Passenger car - off-road	X			X	3	77	~~77~~	~~74~~			
6.2.2.1.3.1	M2	Medium sized bus; mass ≤ 2 tonnes					4	76	76	74	71	72	70
6.2.2.1.3.2	M2	Medium sized bus; 2 tonnes < mass ≤ 3,5 tonnes						77	77	74	71	72	70
6.2.2.1.3.1	M2	Medium sized bus; mass ≤ 2 tonnes	X				1	77	~~77~~	~~74~~			
6.2.2.1.3.2	M2	Medium sized bus; 2 tonnes < mass ≤ 3,5 tonnes	X				7	78	~~78~~	~~75~~			
6.2.2.1.2.1	M2	Medium sized bus; 3,5 tonnes < mass ≤ 5 tonnes; rated power < 150 kW					12	78	78	75	72	73	71
6.2.2.1.2.2	M2	Medium sized bus; 3,5 tonnes < mass ≤ 5 tonnes; rated power ≥ 150 kW					4	80	80	76	73	74	72
6.2.2.1.2.1	M3	Full size bus; mass > 5 tonnes; rated power < 150 kW					11	78	78	77	74	75	73
6.2.2.1.2.2	M3	Full size bus; mass > 5 tonnes; rated power ≥ 150 kW					64	80	80	79	76	77	75
6.2.2.1.3.1	N1	Van; mass ≤ 2 tonnes					21	76	76	73	70	71	69
6.2.2.1.3.2	N1	Van; 2 tonnes < mass ≤ 3,5 tonnes					6	77	77	74	71	72	70
6.2.2.1.3.1	N1	Van; mass ≤ 2 tonnes	X				3	77	~~77~~	~~73~~			
6.2.2.1.3.2	N1	Van; 2 tonnes < mass ≤ 3,5 tonnes	X				22	78	~~78~~	~~74~~			
6.2.2.1.3.2	N1G	Van - off-road; 2 tonnes < mass ≤ 3,5 tonnes			X		2	78	78	74	71	72	70
6.2.2.1.3.2	N1G	Van - off-road; 2 tonnes < mass ≤ 3,5 tonnes				X		79	~~79~~	~~74~~			
6.2.2.1.3.2	N1G	Van - off-road; 2 tonnes < mass ≤ 3,5 tonnes	X		X		1	79	~~79~~	~~73~~			
6.2.2.1.3.2	N1G	Van - off-road; 2 tonnes < mass ≤ 3,5 tonnes	X			X		80	~~80~~	~~74~~			
6.2.2.1.4.1	N2	Lorry; 3,5 tonnes < mass ≤ 12 tonnes; rated engine power < 75 kW					1	77	77	75	73	74	72
6.2.2.1.4.2	N2	Lorry; 3,5 tonnes < mass ≤ 12 tonnes; 75 ≤ rated engine power < 150 kW					40	78	78	76	74	75	73
6.2.2.1.4.3	N2	Lorry; 3,5 tonnes < mass ≤ 12 tonnes; rated engine power ≥ 150 kW					14	80	80	78	76	77	75
6.2.2.1.4.2	N3	Heavy truck; mass > 12 tonnes; 75 ≤ rated engine power < 150 kW						78	78	78	76	77	75
6.2.2.1.4.3	N3	Heavy truck; mass > 12 tonnes; rated engine power ≥ 150 kW					100	80	80	81	79	80	78
6.2.2.1.4.2	N3G	Heavy truck - off-road; mass > 12 tonnes; 75 ≤ rated engine power < 150 kW			X			79	79	79	77	78	76
6.2.2.1.4.3	N3G	Heavy truck - off-road; mass > 12 tonnes; rated engine power ≥ 150 kW				X	39	82	82	83	81	82	80

Evaluation method B

Questions:

- What is effectiveness of method B compared to A, with respect to:
  - Practical applicability
  - Representativeness of results for noise emission in normal traffic
  - Significance of results for other operating conditions (off-cycle emissions)
  - Prevention of adapting or optimising vehicles to test conditions
  - Control of selection of test tyres on heavy trucks

Presented information based on enquiry among type approval authorities

Operability / complexity of method B

Light vehicles (M1, N1 , N2<3,5t)

- Method B reproducible and manageable
- Method B for light vehicles 3 times more complex than method A
- Choice of gear ratio and approach speed less obvious
- Higher chance of mistakes
- Results more dependent of ability of the test driver
- Method B lower noise levels → more sensitive to environmental parameters and background noise → lower reproducibility than method A
- Instructions for use of gears for lockable automatics ambiguous

Buses: complexity A and B equal

Heavy vehicles

- Method B: loading instructions complex + ambiguous
- Method B: testing in less gears than method A

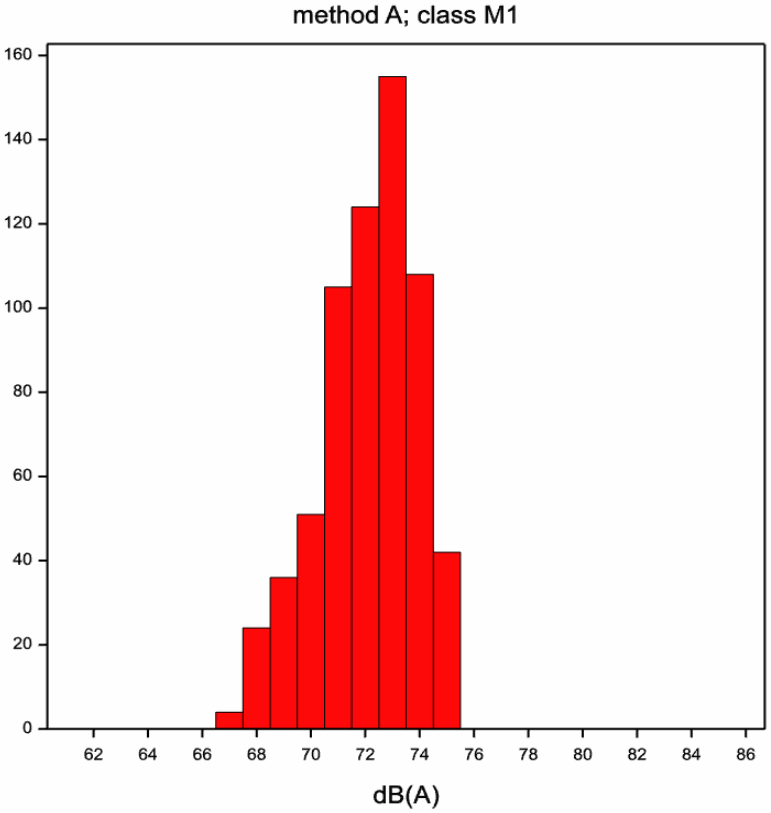
Representativeness of method B

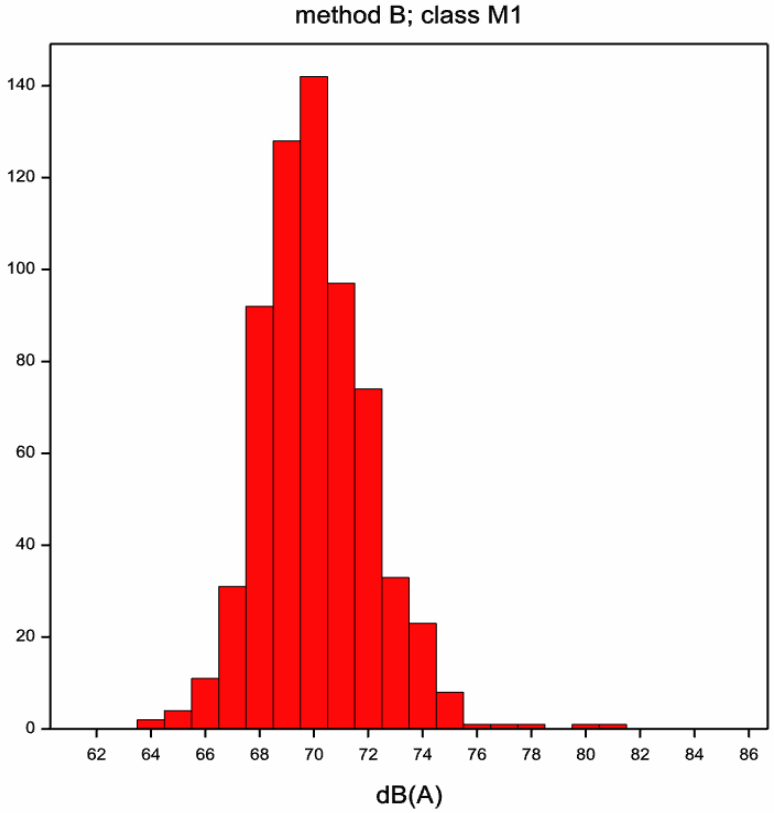
- Test conditions method B more representative for urban driving than method A
- For some vehicles (e.g. light sports cars) choice of gears not representative for normal driving at prescribed speed
- At this moment no engineering of vehicles to the test conditions of method B → test conditions are representative for other conditions too → this may change in time
- Some noise generation mechanisms (e.g. high rev. exhaust noise) not addressed in representative way
- Contribution of tyre rolling noise to final test result:
  Estimation for light vehicles: 48 % (-3,2 dB)

Optimisation of vehicles to test conditions (1)

- Current vehicles optimised to method A → no vehicle exceeds limit values
- For method A high level cut-off of distribution
- For method B no cut-off; more Gaussian shape of distribution
- Some vehicles in test B above current limit values
- Apparently no “engineering to the test” yet
- Optimisation is considered feasible for method B too
- Estimated effect of optimisation for passenger cars:
  - 1 – 7 dB(A) for 10 – 15 % of vehicles
  - See histograms M1 vehicles

Optimisation of vehicles to test conditions (2)





Control of selection of test tyres on heavy trucks

Enquiry type approval bodies:

- In method A no strict instruction for choice of tyres
- Method B: tyres “shall be representative for the axle”
- Question: Is this requirement sufficient to prevent misuse?
- At this moment requirement seems to work
- Control of compliance with requirement difficult

Circa data base:

- For trucks different test tyres for method B than for method A
- N3 vehicles: results test B 1,2 dB(A) higher than test A
- N3G vehicles: results test B 0,6 dB(A) higher than test A
- Comparison traction tyres vs. steering tyres on drive axle:
  →difference 0,6 – 1,0 dB(A)
- Influence of test tyres on WOT test result not very significant

Recommendations for modification test method B

- Delete limitation of acceleration in WOT test of 2 m/s^2;
- Revise instruction for choice of gear for lockable automatics;
- Revise instructions for loading of heavy vehicles.

Off-cycle emission provisions (1)

General goals:

- Cover operating conditions not included in type test
- Noise emission never significantly higher than expected from:
  - Type approval test
  - Normal physical relation of noise with engine speed
- Minimise cycle beating possibilities
- Support law enforcement / in-use compliance
- Support conformity of production (COP) testing

Off-cycle emission – Evaluation GRB ASEP

ASEP = Additional Sound Emission Provision

- 2 methods proposed: GRBIG & NL
- Starting point both methods: noise level $L_{WOT,i}$ method B
- Method GRBIG:
  - Primarily aimed at testing of linearity of noise - engine speed curve
  - Slope of curve based on noise test results of vehicle
  - No upper limit for noise emission
- Method NL:
  - Primarily aimed at setting a noise emission limit in addition to method B
  - Slope of curve determined by predefined maximum noise emission level
  - Can provide upper limit for noise emission within ASEP control range

Off-cycle emission – Evaluation GRB ASEP(2)

Pro's and Con's

+ Method 2 more distinguishing between normal and noisy vehicles
+ Method 2 reduces possibility of engineering to the test conditions
+ Both methods do not give false negative result for normal vehicles
- Both methods only effective within ASEP control range
- Method 1 provides margin for extra noise emission
- Method 1: no maximum allowed noise level
- Both methods based on engine speed → not useful for alternative drive systems
+ Method 2 easier to modify to vehicle speed dependency

→ Preference: method 2 (with reservations → modifications recommended → see VENOLIVA report)

Final results impact assessment

→ Michael Dittrich

Summary of Policy Options

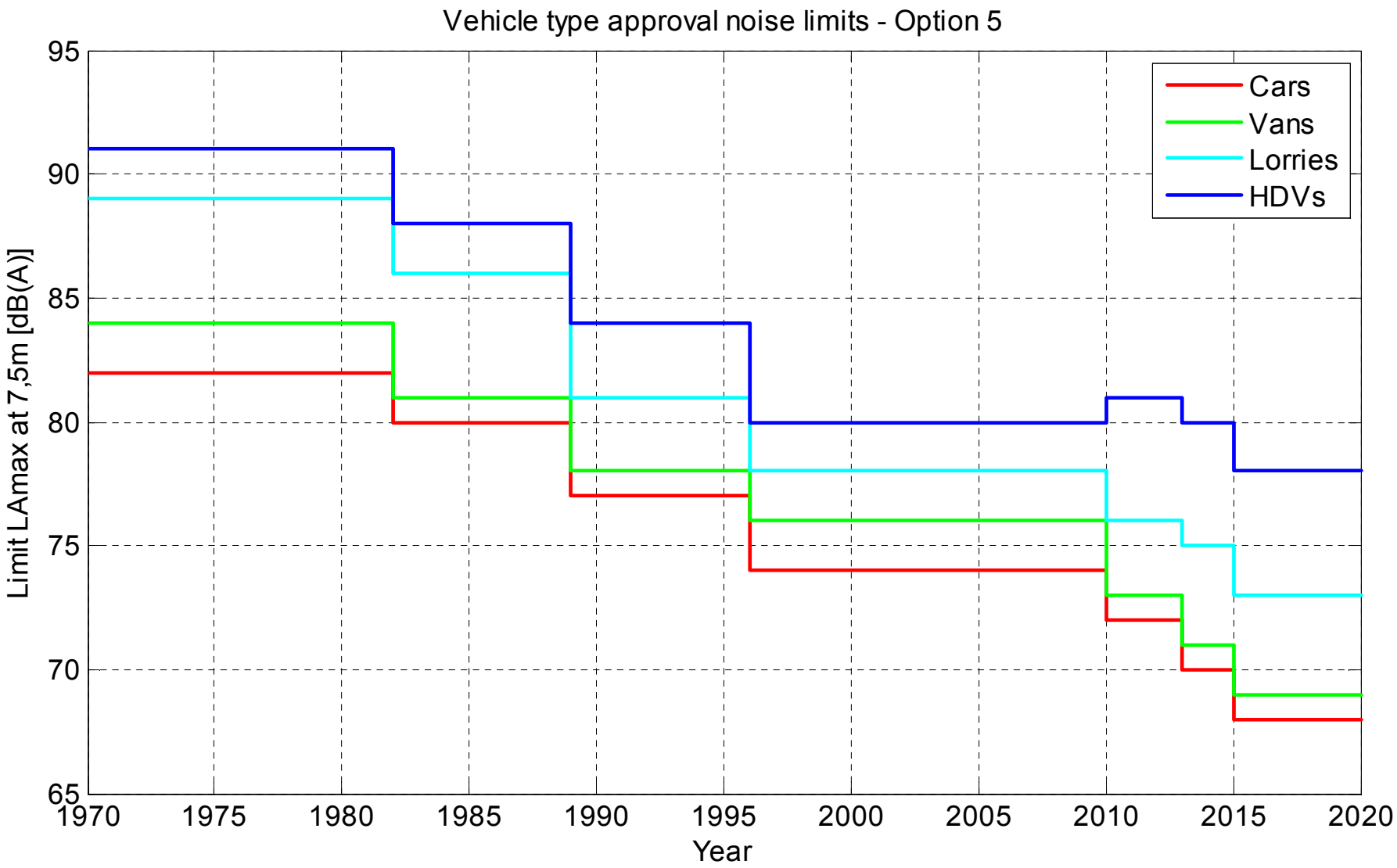
- Option 1 – No environmental benefit
  - Method A no advantage over method B
  - Not recommended
- Option 2 – In fact increase of limit values
  - Negative environmental effect
  - Not advisable
- Option 3 – No impact on current vehicle fleet
  - No positive environmental effect
  - Not recommended

Summary of Policy Options (2)

- Option 4 – Reduction traffic noise impact:
  - free flowing traffic: 2,5 dB(A)
  - intermittent traffic: 2,8 dB(A)
  - – Reduction number highly annoyed people 20%
  - – Economic consequences manageable
  - – Recommended, but less effective than option 5

- Option 5 – Reduction traffic noise impact:
  - free flowing traffic: 3,1 dB(A)
  - intermittent traffic: 4,0 dB(A)
  - – Reduction number highly annoyed people 25%
  - – Economic consequences manageable
  - – Recommended as most effective option

Policy option 5 in historical perspective



Thank you for your attention !!!