Submitted by the expert from OICA

Informal document **GRB-53-04**
(53rd GRB, 15-17 February 2011
agenda item 3(b))

REGULATION No. 51 (Sound emissions of M and N categories of vehicles)

OICA position on the introduction of the new test measurement method
according to Method B in Regulation No. 51

Transmitted by OICA

OICA provides herewith results and conclusions about the analysis of the data that have been collected during the monitoring phase for ECE R51 and 2007/34/EC in the period between July 2007 and July 2010 for the comparison of the new test method with the current test method in force and has derived to a result for possible "equivalent sound levels"– applicable in due time. This analysis is based on the outcome of the VENOLIVA Study as well as on the outcome of ACEA-study carried out by UTAC/TÜV Nord.

1. Class Definitions

TNO made their assessment on the basis of the current vehicle classes and subclasses, which are more than 25 years old. OICA, however, proposes to **re-consider the class definitions** and to adapt them according to the technical progress and to sharpen the original scope. The data analysis carried out by UTAC/TÜV on behalf of ACEA is based on these revised vehicle class definitions.

In the new test procedure, the major control parameter for M1 vehicles is the power-mass-ratio PMR. It seems to be logical to assess the test results as function of PMR. This is shown in the diagram below:

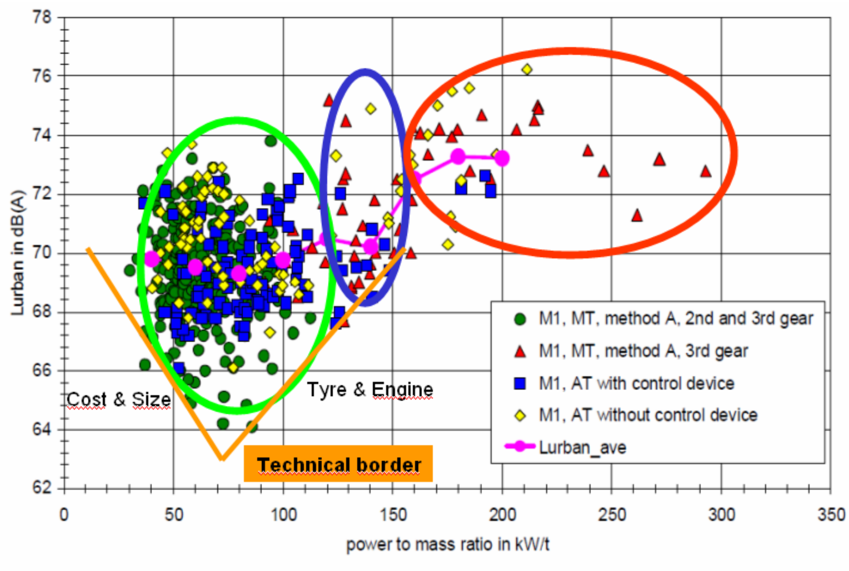


Figure B 9 : Lurban versus power to mass ratio for M1 on road vehicles

For the assessment of potential vehicle subclasses, it is interesting to evaluate the lowest threshold for vehicle technology. This border of technology has a V-shape. In the area of very low PMR the costs and a compact design are the most important factors. The tyres for these vehicles belong mostly in the classes C1A and C1B and contribute less to the overall result compared to the average vehicle. In the higher PMR area, the vehicles have wider tyres and bigger engines and therefore a much higher sound radiation because of the bigger surface. Above a PMR of 150, tyres of class C1E are used with a special focus on performance and safety. The engine sizes are larger and have to fit in an extremely compact design.

For the further assessment of the data it makes sense to **split the M1 vehicle class into three sub-classes**, one below a PMR of 125; one with a PMR between 125 and 150; one with a PMR greater than 150.

In addition, **off-road vehicles** must be dealt as a separate class. While TNO assessed these vehicles in their study using the current off road definitions from R.E.3, OICA supports two more criteria for the noise regulation as discussed in 2004. With the additional requirements of hill climbing capability of 30% and a wading depth of 50 cm it is insured that only vehicles capable for real off road use will belong to this class.

The group of **N1 vehicles** should be divided into the group of vehicles which are generic M1 and those which are down-sized N2 vehicles or respectively “real N1”-Vehicles. The diagram below shows that these very different vehicle technologies can easily be determined also from a sound emission point. Today, the regulation divides the N1 vehicles in two classes with a split at 2000 kg. Following the trend of technology the split of these vehicles is today higher and can be found at 2500 kg maximum vehicle weight (GVW). The diagram below shows the data analysis over the test mass.

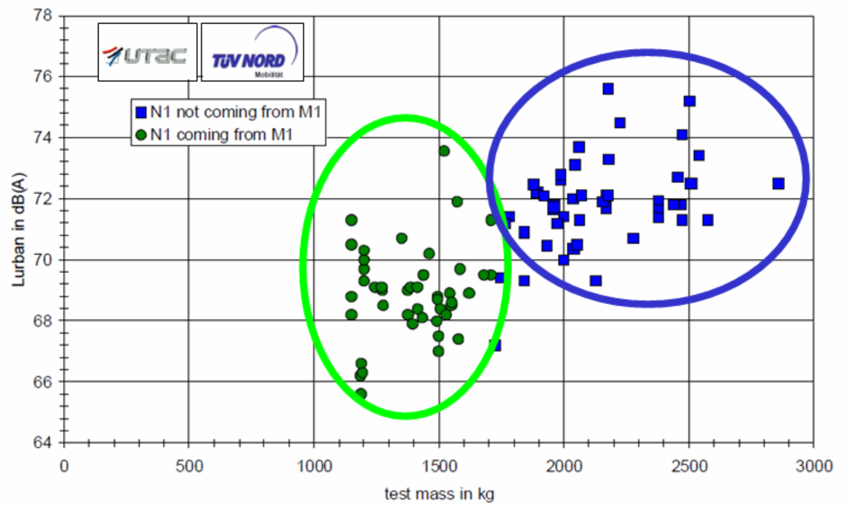


Figure B 12 : Method B results (Lurban) for N1/M2-A vehicles versus test mass

The monitoring data have been made primarily for the European market. Some vehicle types such as the very small N1 commercial vehicles mainly developed in Japan and distributed widely in the Asian regions are the Kei-cars. Data provided by JAMA can be added to the above diagram and reveal another independent group of vehicles. As Kei-cars have very small engines and a limited power they can be separated from the other N1 vehicles using a PMR on the basis of the gross vehicle weight with a value of 35.

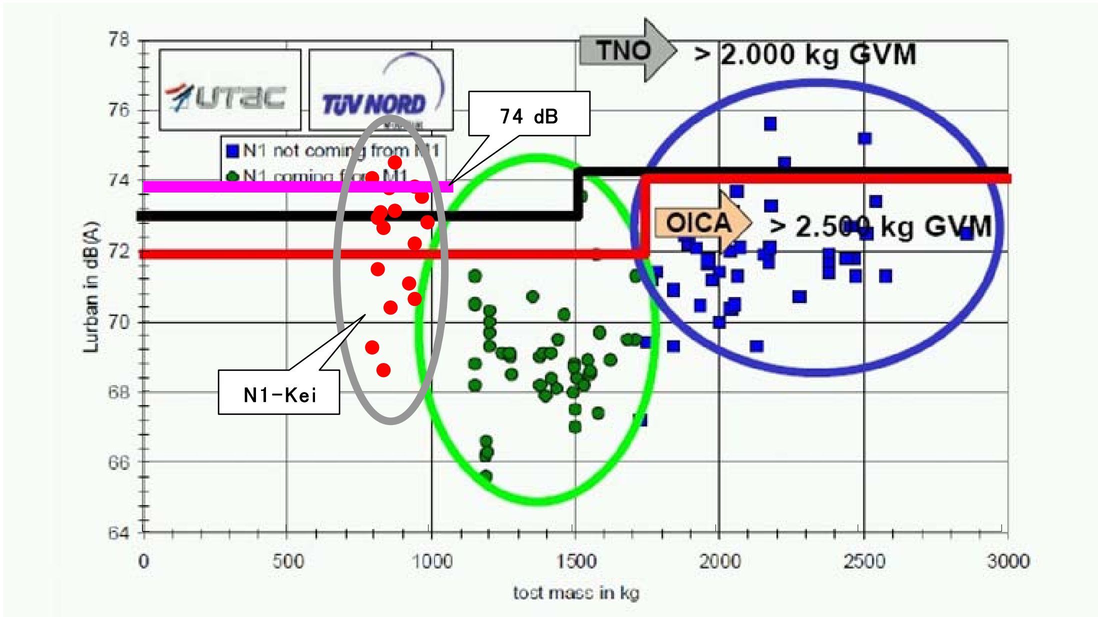


Figure B 12 : Method B results (Lurban) for N1/M2-A vehicles versus test mass

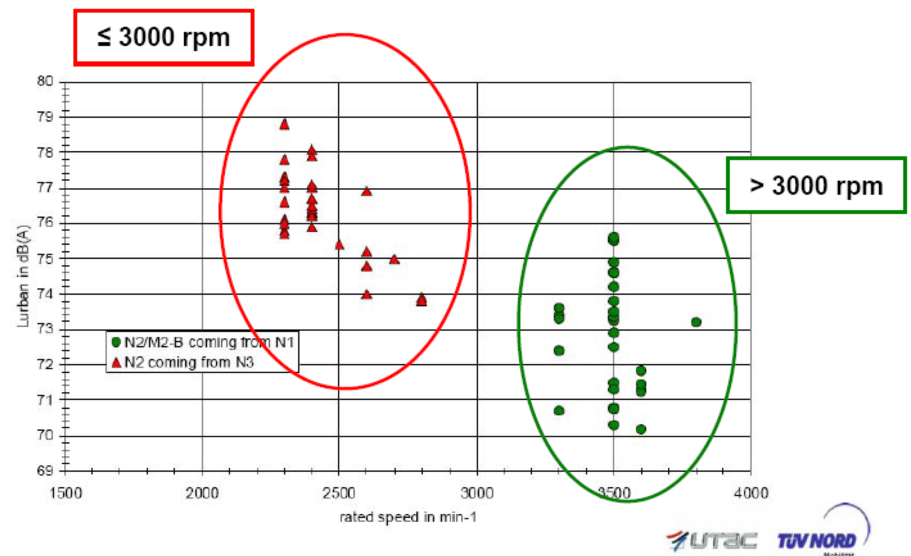
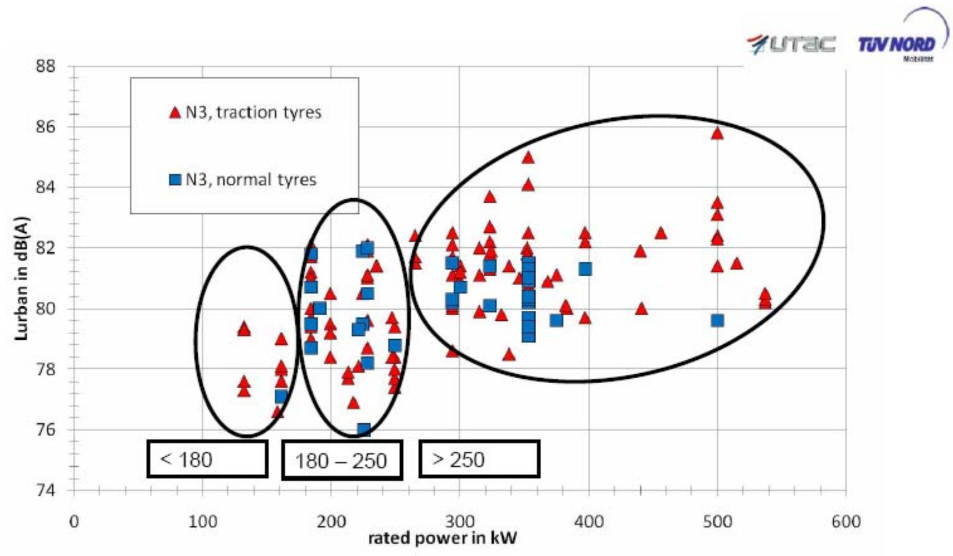


Figure B 16 : Lurban versus rated speed for N2/M2-B vehicles

The group of engines which are derived from N3 engines are gathered around 2500 rpm maximum rated engine speed. The other group which have a higher engine speed is gathered around 3500 rpm. Logically the group for M2 > 3500 kg and N2 should be divided into two one with a maximum rated speed engine S which does exceed 3000 rpm and one which does not exceed 3000 rpm.

For vehicles of category N3 the data analysis showed that the major control parameter is the engine power in kW as can be seen in the figure below.



Source: ACEA, Data delivered to EC monitoring data base during monitoring period 2007-2010

From the results three subgroups can be derived; the first one with en engine power of less than 180 kW, the second one with a power range between 180 kW and 250 kW and the third one with a power of more than 250 kW. These values are slightly higher than the ones which are used today below 150 kW, up to 225 kW and above 225 kW. But they reflect the today's development of new engines which are mainly controlled by the legislation demand for gaseous emissions.

In addition to the vehicles of category N3 the subgroups for category M3 looks the same. The major reason for this is the fact that no special engines are developed for buses. The engines which are used are engines which are developed for vehicles of category N3 in the first place. This is shown in the figure below.

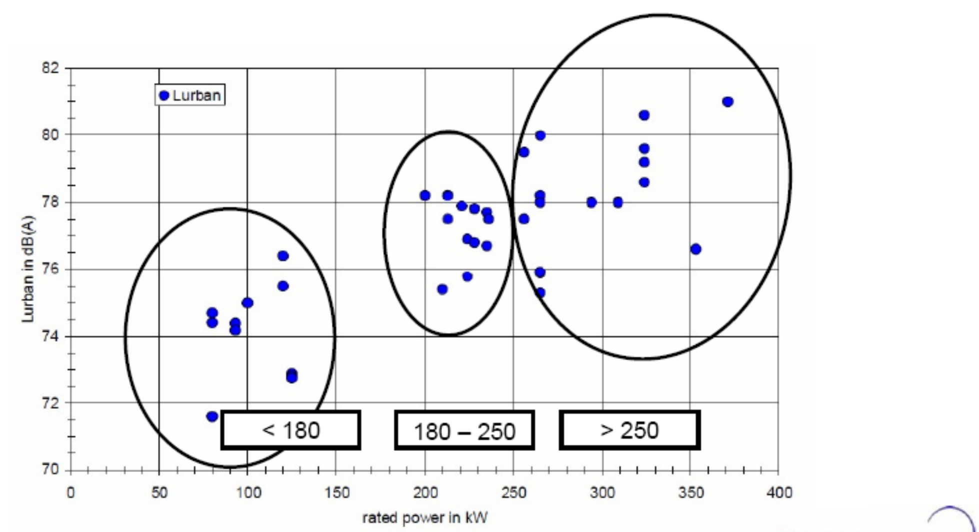


Figure B 32 : results of method B (Lurban) versus rated power for M3 vehicles

Logically the vehicles of category M3 can be divided also into three subclasses; the first one with en engine power of less than 180 kW, the second one with a power range between 180 kW and 250 kW and the third one with a power of more than 250 kW.

2. **Development of “Equivalent sound values”**

The aim for “equivalent sound values” - in the TNO study dealt as policy option 3 - is to determine a starting point for considering more stringent requirements. An introduction of the new test method with such values would mean neither an improvement nor a degradation of the current environmental situation. For the vehicle industry these values should be easy to comply with.

However, there is **no real correlation between the current and new test method** as shown in the TNO study on page 40. Thus it is difficult to evaluate sound values which will fulfil the foresaid aim. The TNO report is unclear about the analysis strategy finally chosen to determine the values given as option 3. Three different assessment criteria are reported: The calculation method based on the regression curve between method A and method B; the comparison of the average result for method A and method B for every particular class; and applying a cut of 5% to 15% in the frequency distribution for the sound levels derived in method B. The first method is not very realistic to apply as the correlation is extremely poor between both test methods. The comparison of the average has the gap that it contains no information about the variability, or statistical distribution, of the data. Hence a proper assessment is only viable using the cut in the statistical distribution curves.

In the ACEA study, this strategy is used for the vehicle sub-classes as determined under item 1) above. The diagram below shows the result for the four determined M1 classes:

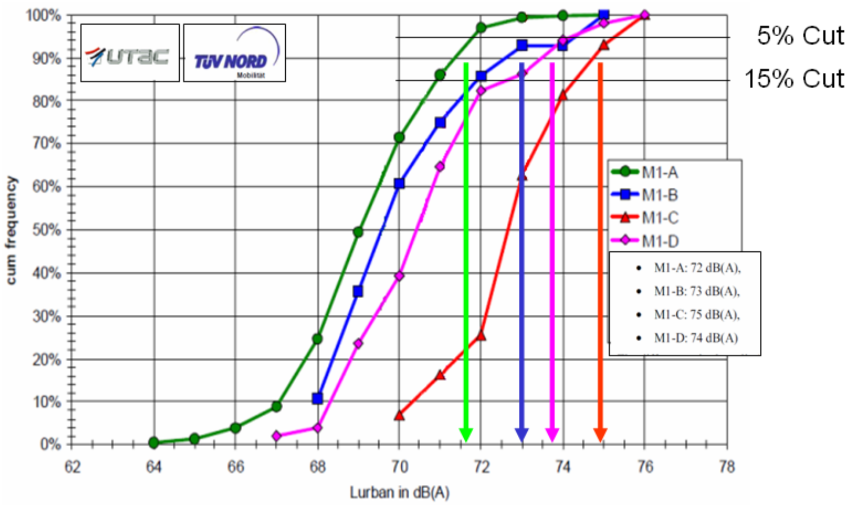


Figure B 10 : Cumulative frequency distributions and average Lurban values for the three proposed on road M1 vehicle classes

The elaborated sub-groups clearly differ from each other, not only with respect to the result of the approximately 10% cut, but also with regard to the lowest value in the sub-group. For sub-class M1a, vehicles with an L_{urban} value of 64 dB(A) are present. In the other three groups, the lowest available values are much higher and range from 67 dB(A) for M1d, 68 dB(A) for M1b, up to 70 dB(A) for M1c.

The newly defined off-road class contains a rather small vehicle population and according to the data analysis of UTAC and TÜV, a further split with regard to the power of the vehicle is not needed. The population for N1 G is very small in the database (only 3 vehicles). Therefore, the value of M1 G is overtaken for the smaller N1 G class. For N1 G over 2500 kg gross vehicle weight, the value is somewhat higher and linked to the class N2 G.

M1		M1 G (accord. R.E.3 Annex 7)	
Value [dB(A)]	**Criteria PMR**	**Value [dB(A)]**	**Criteria**
72	≤125 kW/t		plus Climbing Capability of ≥ 30%
73	125 ... 150 kW/t	74	
75	> 150 kW/t		plus Wading Depth ≥ 50 cm

N1		N1 G (accord. R.E.3 Annex 7)	
Value [dB(A)]	**Criteria**	**Value [dB(A)]**	**Criteria**
72	GVW ≤ 2500 kg	74	≤ 2500 kg
74	PMR(GVW) < 35		
74	GVW > 2500 kg	75	> 2500 kg

With the same approach the results for the heavy commercial vehicles of category M2 < 3500 kg (named M2-B), and N2 are looking as followed.

M2-B		M2-BG	
76	> 3000 rpm	77	> 3000 rpm
78	< 3000 rpm	79	< 3000 rpm

N2		N2G	
76	> 3000 rpm	77	> 3000 rpm
78	< 3000 rpm	79	< 3000 rpm

For vehicles of category M3 the results for the three subclasses are presented in the following table.

M3		M3G	
76	< 180 kW	77	< 180 kW
78	180 ... 250 kW	79	180 ... 250 kW
80	> 250 kW	81	> 250 kW

For vehicles of category N3 the results for the three subclasses are highly depending on the selection of the tyre on the drive axle(s). If tyres are used which are representative for the axle(s) the three subclasses related to the power of the engine are only valid for two-axle vehicles. For vehicles with more than two axles an additional subclass is proposed which is only depending on the tyre/road noise under torque.

N3		N3G	
79	2 axles <180kW	80	2 axles <180kW
81	2 axles 180 … 250kW	82	2 axles 180 … 250kW
82	2 axles >250kW	83	2 axles >250kW
84	> 2 axles	85	> 2 axles
Limits are applicable with tyres representative for the axle(s)			

The reasons for this have been under discussion during the last two GRB meetings and are highlighted in two informal documents by OICA and one informal document by ETRTO.

Reference 1: Informal document GRB 51-20 by OICA
http://www.unece.org/trans/doc/2010/wp29grb/ECE-TRANS-WP29-GRB-51-inf20e.pdf

Reference 2: Informal document GRB 52-04 by OICA
http://www.unece.org/trans/doc/2010/wp29grb/ECE-TRANS-WP29-GRB-52-inf04e.pdf

Reference 3: Informal document GRB 51-13 by ETRTO
http://www.unece.org/trans/doc/2010/wp29grb/ECE-TRANS-WP29-GRB-51-inf13e.pdf
The results of the discussions are summarized in the minutes of the 51st session of GRB and the 52nd session of GRB. A solution for how to solve this item is proposed by OICA and is presented as a working document No 7 for the 53rd session of GRB.

Reference 4: Minutes of 51st session of GRB
http://www.unece.org/trans/doc/2010/wp29grb/ECE-TRANS-WP29-GRB-49e.pdf

Reference 5: Minutes of 52nd session of GRB
http://www.unece.org/trans/doc/2010/wp29grb/ECE-TRANS-WP29-GRB-50e.pdf

Reference 6: Working document for 53rd session of GRB
http://www.unece.org/trans/doc/2011/wp29grb/ECE-TRANS-WP29-GRB-2011-07e.pdf

If the question about the selection of the tyre to be used for the test can be solved according to the proposal by OICA the new subclasses for vehicles of category N3 are only depending on the power of the engine like it is valid today. The table below takes into account this change.

N3		N3G	
79	<180kW	**80**	<180kW
81	180 … 250kW	**82**	180 … 250kW
82	>250kW	**83**	>250kW
Limits are applicable with tyres representative for the vehicle			

The values given in the tables above are the result of simple statistical analysis with a clear definition for every sub-class and a consequently applied uniform assessment criteria. The values represent what can be considered as a “neutral” introduction of the new test procedure. These values will not degrade the current environmental situation. It does impose a burden that 10% of new vehicle types must be improved. However, OICA members are confident that with introduction of these values, the new test procedure can be introduced on a short term.

3. Impact of Tyre Regulation ECE R117

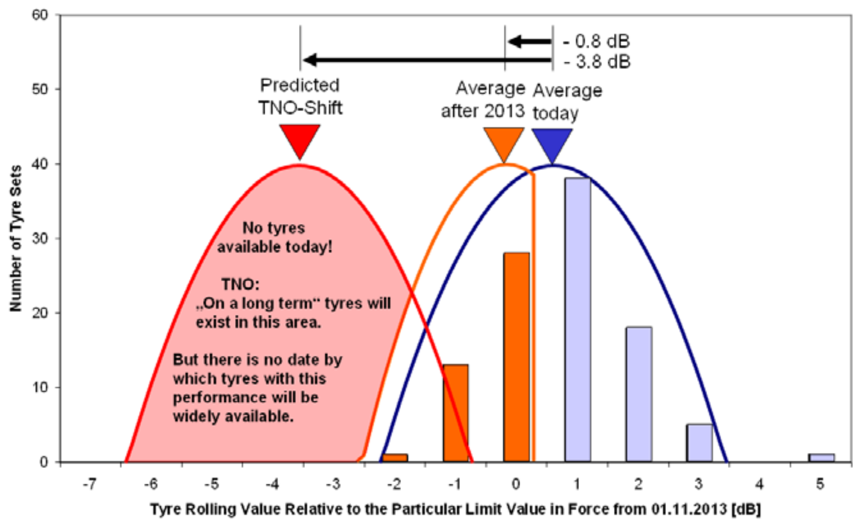
TNO assessed the potential impact of the future tyre noise standards which will become mandatory for vehicle OEMs from November 2013. The general conclusion was that this limit reduction will result “on a long term” - in an average reduction of 3,8 dB(A) of the limit values for car tyres and of approximately 3,3 dB(A) for the limit values for truck tyres. TNO assumes a general tyre noise shift of 3,8dB(A) when the new limit values will enter into force. The spread of noise emission values in most tyre classes is approximately 5 to 6 dB(A) below the current limit values.

OICA, however, is of the strong opinion that average noise values of future tyres will go down by only approximately 1dB, expecting that the introduction of the stricter limit values will result in the cut-off of the tyre populations at the future limit values *(Without cross-considering the different definitions of the type of both tyres and vehicles with respect to their noise emissions, and the consequences in terms of extensions of type approval or "family coverage" rules which might follows)*.

It is important to NOT mixing up the following measures:
a) the reduction of the **limits for noise** introduced by R117.02 for the tyres put on the market within a period from November 2012 to 30 months after November 2018, with a main impact on purging and **improving After-Market-Tyres**
c) and the potential reduction of the **type-approval** noise values of those **Original-Equipment-Tyres** selected by the vehicle manufacturers and fitted in their plants on the brand-new vehicles

Knowing the severe selection already done by the vehicle manufacturers, the effect of future tyre noise limits can thus be estimated to an average vehicle noise reduction of approximately 0,5 dB.

As there is today - almost two years before the introduction of the new tyre regulation - no indication that significantly quieter tyres will be available, OICA expects that the spread in tyres will shrink to approximately 2 dB(A) shortly after introduction of the regulation. The diagram below gives an impression of the actual tyre situation. The data are from "Stiftung Warentest" which performs annual tyre tests for customer information. During the testing, the rolling sound emission of the tyres is measured. It gets obvious that in the TNO expectation range currently nearly no tyres are available.



Another point that is not addressed in the TNO study is the **difference in testing conditions** between the tyre regulation and the vehicle regulation. Tyres have variable dependency in sound emission versus the speed. This variance spoils the direct transposition of the achievements at the test condition of ECE R117 to the test conditions of ECE R51.

Also, the **torque effect** is not addressed by TNO. This torque effect is a function of the acceleration, the tyre design, and the test track. Increasing the maximum physical acceleration from 2 m/s² to 3 m/s² as proposed in the TNO study will make the torque effect the dominant part source of the tyre in the pass-by measurement. This is an unrealistic test condition with respect to real urban driving. Tyre manufacturers will be forced to optimize the tyre rolling sound based on a wrong excitation model.

For every vehicle type, the tyres are developed individually. The foresaid additional drawbacks cannot be neglected and must be resolved during the development. Therefore, a sufficient population of these very low noise tyres is needed to create a solid basis of technologies.

For heavy commercial vehicles the change in the Tyre Regulation ECE R117 has no influence at all on the outcome of the proposed values because it is only addressing the sound of the rolling tyre under high speed. The torque effect which was mentioned earlier has not been taken care of by the Tyre Regulation. As for vehicles of category M1 and N1 the torque effect is a function of the acceleration, the tyre design and the test track. For vehicles of category N3 the sound levels increase by approx. 0,7 dB/1000 Nm torque at the drive axle when traction tyres are used. When normal tyres are used the increase is reduced down to 0,1 dB/1000 Nm. For more information see reference 1, 2 and 3.

4. Progressive Noise Limit Values

The "equivalent sound values" enable a transparent discussion about the enforcement of limit values. Lower values will require development work and thus sufficient lead time is needed. Depending on the discrete vehicle technology, either improvements on the power train, the gas flow, or the tyres are necessary or any combination of these sources. This can normally be done within a normal vehicle development cycle, if the necessary information is known in the concept and design phase, which will require a lead time of five years.

The diagram below shows the implementation of new requirements compatible with the vehicle development cycle, assuming that in 2013 the official approval by WP 29 for future limits **with** increased stringency.