

**Draft proposal for changes to the text of  
TRANS/WP.29/GRB/2005/2/Rev.2 (R51.03)  
In order to incorporate the Additional Sound Emissions Provisions  
Issued by the Chairman of the ASEP group  
d.d. September 13 2007**

**Text marked in blue bold has been changed or added compared to the original document  
TRANS/WP.29/GRB/2005/2/Rev.2**

~~Text crossed out has been removed~~

***Text marked in green bold italic has been added for clarification***

**Main body**

6.2.3. **Additional sound emission provisions**

The additional sound emission provisions apply to vehicles of categories M1 and N1 only.

They are preventive requirements intended to also cover driving conditions of the vehicle in real traffic, which can be environmentally relevant concerning their sound emission and which differs from those during type approval, described in Annex 3.

6.2.3.1. The vehicle manufacturer shall not intentionally alter, adjust, or introduce any mechanical, electrical, thermal, or other device or procedure solely for the purpose of fulfilling the noise emission requirements as specified in this regulation and as determined by the test procedure of Annex 3 but which will not be operational during typical on-road operation. These measures are commonly referred to as "cycle detection".

6.2.3.2. Any control device, function, system or measure that could affect the noise output may be installed on a vehicle provided that:

- it is activated only for such purposes as engine protection, cold starting or warming up, or
- it is activated only for such purposes as operational security or safety and limp-home strategies, or
- it is required to fulfil this and/or other regulations

**[6.2.3.3. The sound emission of the vehicle under normal driving conditions different from the conditions of the type approval test in Annex 3 shall not differ considerably from what can be expected from the type approval test result for this specific**

**vehicle with regard to technical practicability. This is fulfilled if the requirements of Annex 10 are met.]<sup>1</sup>**

**6.2.3.4. The vehicle shall meet the requirements of annex 10**

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<sup>1</sup> Text in bold as in Reg51/2 ; bold means 1. item to be considered by GRB experts or 2. modification to TRANS/WP29/GRB/2005/2/Rev1; in this case it means: to be reconsidered (note chairman: not by our ASEP group).

Annex 1

(Maximum format: A4 (210 x 297 mm))

COMMUNICATION

**To Be Accomplished**

**[Measurement Results of annex 10?]**

**[Declaration of manufacturer for being in compliance with annex 10?]**

Annex 7

CHECKS ON CONFORMITY OF PRODUCTION

1. General

These requirements are consistent with the test to be held to check conformity of production according to paragraph 8. of this Regulation.

2. Testing procedure

The test site and measuring instruments shall be those as described in Annex 3.

2.1. The vehicle(s) under test shall be subjected to the test for measurement of sound of vehicle in motion as described in paragraph 3.1. of Annex 3.

2.2. Compressed air sound

Vehicles having maximum mass exceeding 2,800 kg and equipped with compressed air systems must be subjected to an additional test for measurement of the compressed air sound as described in paragraph 1. of Annex 6.

**2.3. [The vehicle(s) under test shall be subjected to the test for Additional Sound Emission Provisions as described in Annex 10.]**

3. Sampling

One vehicle has to be chosen. If after the test of paragraph 4.1. the vehicle is not considered to conform to the requirements of this Regulation, two more vehicles have to be tested.

4. Evaluation of the results

4.1. If the sound level of the vehicle tested pursuant to paragraphs 1. and 2. does not exceed by more than 1 dB(A) the limit value prescribed in

- paragraph 6.2.2. of this Regulation, for measurement according to paragraph 2.1. above, and in
- paragraph 3. of Annex 6 to this Regulation, for measurement according to paragraph 2.2. above, and in
- **[paragraph 5 of Annex 10 to this Regulation, for measurements according to paragraph 2.3. above,]**

the vehicle type shall be considered to conform to the requirements of this Regulation.

4.2. If the vehicle tested according to paragraph 4.1. does not satisfy the requirements laid down in that paragraph, two more vehicles of the same type shall be tested pursuant to paragraphs 1. and 2.

4.3. If the sound level of the second and/or third vehicle of paragraph 4.2. exceeds by more than 1 dB(A) the limit values prescribed in paragraph ~~6.2.2. of this Regulation~~ **[4.1 above]**,

the vehicle type shall be considered not to conform to the requirements of this Regulation and the manufacturer shall take the necessary measures to re-establish the conformity.

**Annex 10**

**ADDITIONAL SOUND EMISSION PROVISIONS  
applicable for M1 and N1 only**

~~During development of the provisions for off cycle emissions the technical provisions of UNECE Regulation No. 51.02 series of amendments shall be fulfilled.]~~

**1. General**

**By applying for type approval the manufacturer declares that the requirements of this Annex are fulfilled**

**or**

**By applying for type approval the manufacturer has to provide a signed declaration that the vehicle fulfils the requirements of annex 10**

~~The requirements of paragraph 6.2.3. are deemed to be fulfilled, if the vehicle manufacturer can show to the satisfaction of the technical service that the following requirement is fulfilled.~~

**The technical service shall have the possibility to carry out practical tests [and may ask for additional technical information in order to check the compliance of the vehicle with the requirements in this Annex.**

**By granting type approval the Type Approval Authority declares that the requirements of this Annex are fulfilled.**

**2. Requirement**

~~2.1. Documentation~~

~~The manufacturer shall provide a documentation that gives access to the design of the noise reduction system and the means by which it controls the noise output.~~

**The noise emission of the vehicle shall not exceed the limit as given in paragraph 5 when it is measured in any of the possible operation conditions as given in paragraph 3**

**3. Measuring method**

**3.1 measuring instruments and condition of measurements**

**Unless specified differently here after, the measuring instruments, the conditions of the measurements and the condition of the vehicle are equal to those specified in Annex 3 paragraph 1 and 2.**

*Note: In some proposals it has been advised to use continuous measuring equipment*

Some vehicles may have different software programs or modes which affect the acceleration behavior of the vehicle. Such programs may include, but are not limited to, the transmission (e.g. sporty, winter, adaptive, etc.), the electronic stability program (on/off) and the intelligent cruise control (on/off). If the vehicle has different modes leading to valid accelerations, all these modes shall be in compliance with the requirements in this annex.

### 3.2. Method of testing.

Unless specified differently here after, the conditions and procedures of Annex 3 paragraph 3.1 until 3.1.2.1.2.2. have to be used.

### 3.3 Target conditions and boundary conditions

There is not a single target condition for the measurements. There is a range of valid operation conditions which have to fall within the following boundary conditions:

Vehicle speed:	$[20 \leq V_{BB} \leq 80 \text{ km/h}]$
Vehicle acceleration:	$[a_{wot} \leq 4,0 \text{ m/s}^2]$
Engine speed:	$[n_{BB} \leq 2.6 \cdot PMR - 0.29 \cdot (s - \text{nidle}) + \text{nidle}]$
and:	$[n_{BB} \leq 0.9 \cdot (s - \text{nidle}) + \text{nidle}]$

### 3.4 Reference conditions:

Vehicle speed:  $(V_{ref}) = 50 \text{ km/h}$

Engine speed:  $(n_{ref}) = \text{the engine speed at line BB' in the lowest gear ratio } i \text{ as tested in Annex 3}$

### 3.5. Gear ratio selection

The selection of gear ratios for the test depends on their specific acceleration potential  $a_{wot}$  under full throttle condition. All gear ratios leading to a valid operation condition within the boundary condition as specified in 3.3. can be used for the test. Some vehicles may have different software programs or modes for the transmission. In that case the demands of paragraph 3.1 apply.

In case of automatic gear boxes (including adaptive transmissions and CVT's) the test may include a gear change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. A gear shifting to a gear ratio which leads to an acceleration higher than the boundary condition shall be avoided. In that case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions, to prevent a downshift to a gear ratio which leads to an acceleration higher than the boundary condition.

### 3.6. Acceleration test

Pre-acceleration before line AA' may be used to adjust the gear setting of automatic gear boxes and to achieve a more stable acceleration between line AA' and BB'. At the

latest at line AA' the accelerator shall be fully depressed (as rapidly as is practicable). The accelerator shall be kept in this depressed condition until the rear of the vehicle reaches line BB'. The accelerator shall then be released as rapidly as possible.

The maximum A-weighted sound pressure level indicated during each passage of the vehicle between the two lines AA' and BB' (see Annex 8, Figure 1) shall be measured and noted, mathematically rounded to the first decimal place. If a sound peak obviously out of character with the general sound pressure level is observed, the measurement shall be discarded. Left and right side may be measured simultaneously or sequentially. The results of each side shall be evaluated separately.

For every separate noise measurement the following parameters shall be determined and noted:

- The vehicle speed measurements at AA', BB', and PP' shall be noted and used in calculations to the first significant digit after the decimal place.
- The engine speed measurements at AA', BB', and PP' shall be noted and used in calculations to the first significant digit before the decimal place.
- The calculated acceleration  $a_{wot}$  test shall be determined in accordance to the formulas in annex 3 par 3.1.2.1.2 and noted to the second digit after the decimal place.
- The position of the gear selector and (for vehicles with automatic gear boxes) the gear ratio at the moment of measuring the maximum noise.

At least [xx] valid measurements shall be carried out. At least [yy] of them shall have an engine speed  $n_{BB}$  which is higher than the reference engine speed ( $n_{ref}$ ) which is the highest engine speed as tested in Annex 3 ( $n_{BB}$  in gear i). The measurements shall be equally distributed over the range of valid operation conditions.

### 3.7. Coast by test

The maximum sound level expressed in A-weighted decibels (dB(A)) shall be measured to the first decimal place as the vehicle is coasting between lines AA' and BB' (see Annex 8, Figure 1). This value will constitute the result of the measurement.

At least two measurements shall be made on each side of the test vehicle at test speeds lower than the reference speed of 50 km/h. and at least two measurements at test speeds higher than the reference speed of 50 km/h. The speeds shall be approximately equally spaced over the speed range between 30 and 70 km/h.

For every noise measurement, the corresponding vehicle speed measurement at PP' shall be noted and used in calculations to the first significant digit after the decimal place.



*Note: Measurements according to 3.7 and the consecutive analysis according to 4.1 are necessary in conjunction to proposal A for data analysis in 4.2.a, but not for proposal B and C in 4.2.b and 4.2.c.*

#### 4. Analysis and Interpretation of results

##### 4.1 Data processing of coast by noise measurements (calculating $L_{tyre}$ )

The individual coast by noise measurements shall be used to calculate the tyre rolling noise level  $L_{tyre}$  at the reference speed of 50 km/h, by means of a regression analysis according to:

$$L_{tyre} = \bar{L} - a \cdot \bar{v}$$

where:

$\bar{L}$  is the mean value of the rolling noise levels  $L_i$ , measured in dB(A):

$$\bar{L} = \frac{1}{n} \sum_{i=1}^n L_i$$

$n$  is the measurement number ( $n \geq 8$ ),

$\bar{v}$  is the mean value of logarithms of speeds  $V_i$ :

$$\bar{v} = \frac{1}{n} \sum_{i=1}^n v_i \quad \text{with} \quad v_i = \lg( V_i / V_{ref} )$$

$V_{ref}$  is the reference speed of 50 km/h

$a$  is the slope of the regression line in dB(A):

$$a = \frac{\sum_{i=1}^n (v_i - \bar{v}) (L_i - \bar{L})}{\sum_{i=1}^n (v_i - \bar{v})^2}$$

##### 4.2 Data processing of accelerated noise measurements (calculation of expected noise level)

*Note: Currently there are three proposals under discussion for data processing. These proposals are given in paragraph 4.2a to 4.2c.*

*Note: In the following sub-paragraphs readings are assumed to be taken at line BB'. Currently it is still under discussion whether readings should be taken at PP', BB' or at Lmax. In the latter case more sophisticated (continuous) measuring equipment is necessary, both for annex 3 and annex 10 measurements as compared to the current annex 3 procedure.*

**4.2a. proposal A based on an expected increase of noise versus engine speed and vehicle speed:**

*Note: Following the discussions in the 7<sup>th</sup> meeting, this proposal might be changed. As soon as an updated text version of this proposal has been received it will be incorporated.*

*Note: The boundaries and exact solutions in 4.2.1 to 4.2.3 are still under discussion*

**For the purpose of this regulation the following simplified noise model applies:**

**4.2.1 If  $L_{wot,i} - L_{tyre}(v_{BB,i}) \geq [8]$  dB(A),  
the expected vehicle noise is**

$$L_{vehicle,expected}(n) = L_{wot,i} + b \cdot (n - n_{ref})$$

$$b = 5 \text{ dB/1000 1/min for } n > n_{ref} \text{ and} \\ = 4 \text{ dB/1000 1/min for } n < n_{ref}$$

**4.2.2 If  $[3] < L_{wot,i} - L_{tyre}(v_{BB,i}) < [8]$   
The total expected vehicle noise is a function of engine speed (n) and vehicle speed (v)  
and is an energetic sum of engine noise and tyre noise according to**

$$L_{vehicle,expected}(n,v) = 10 \cdot \log(10^{(L_{engine}(n)/10)} + 10^{(L_{tyre}(v)/10)})$$

**Where**

- $L_{tyre} = L_{tyre}(v_{ref}) + a \cdot \log(v/v_{ref})$ , and
- $L_{engine} = L_{engine}(n_{ref}) + b \cdot (n - n_{ref})$

**In which**

- $v_{ref} = 50 \text{ km/h}$
- $L_{tyre}(v_{ref})$  and  $a$  have to be determined by coast by measurements according to the procedure in paragraph 3.7 and 4.1

**and**

- $n_{ref}$  is equal to the engine speed at BB' as measured in annex 3 in gear i ( $n_{BB,i}$ )
- $b = 5 \text{ dB/1000 1/min for } n > n_{ref} \text{ and} \\ = 4 \text{ dB/1000 1/min for } n < n_{ref}$
- $L_{engine}(n_{ref}) = 10 \cdot \log(10^{(L_{wot,i}/10)} - 10^{(L_{tyre}(v_{BB',i})/10)})$
- $L_{wot,i}$  and  $v_{BB',i}$  are taken from the measurement results in gear i in annex 3.

**4.2.3 If  $L_{wot,i} - L_{tyre}(v_{BB,i}) \leq 3$  dB(A),**

**the vehicle is excluded from further evaluation and is considered to be in compliance with the annex 10 demands.**

**4.2.4 Every individual noise measurement  $L_{wot}$  as derived from 3.6, together with its simultaneously measured engine speed and vehicle speed at line BB' ( $n_{BB'}, v_{BB'}$ ), shall be compared to the expected vehicle noise  $L_{vehicle,expected}(n_{BB'}, v_{BB'})$ .**

$$L_{\Delta} = L_{wot} - L_{vehicle,expected}$$

**All results shall be noted in a table. The columns shall contain the test and analysis results ( $L_{\Delta}$ ,  $L_{wot}$ ,  $L_{vehicle,expected}$ ,  $n_{BB'}$ ,  $v_{BB'}$ , gear ratio), the rows shall contain the sequential measurements (1,2,3...).**

**For easy evaluation, a graph may be used where the noise values are plotted as a function of engine speed. Measurements in different gear ratios shall be grouped together with specific colors or markings. In case of fixed gear ratios, lines shall be drawn for the  $L_{vehicle,expected}(v)$  in every gear ratio separately. The measurement from annex 3  $L_{wot,i}$  shall be marked separately.**

**4.2.b. proposal B based on expected linearity of noise versus engine speed**

*To be accomplished.*

*Note: Following the action points in the 7<sup>th</sup> meeting, this proposal will be translated in to text. As soon as a text version of this proposal has been received it will be incorporated.*

**4.2.c. proposal C based on an expected increase of noise versus vehicle acceleration and vehicle speed:**

**For the purpose of this regulation the following simplified noise model applies:  
The expected vehicle noise is**

$$[L_{vehicle,expected}(a,v) = L_{urban,annex3} + 4*(a_{WOT,test} - a_{urban}) + 0,3*(v_{PP'} - 50)]$$

**Every individual noise measurement  $L_{wot}$  as derived from 3.6, together with its simultaneously measured acceleration and vehicle speed at line PP' ( $a_{WOT,test}$ ,  $v_{PP'}$ ), shall be compared to the expected vehicle noise  $L_{vehicle,expected}(a_{WOT,test}, v_{PP'})$ .**

$$L_{\Delta,annex 10} = L_{wot} - L_{vehicle,expected}$$

$$L_{\Delta,annex 3} = Limit_{annex3} - L_{urban,annex3}$$

$$L_{\Delta} = L_{\Delta,annex 10} - L_{\Delta,annex 3}$$

All results shall be noted in a table. The columns shall contain the test and analysis results ( $L_{\text{delta,annex 10}}$ ,  $L_{\text{delta,annex 3}}$ ,  $L_{\text{delta}}$ ,  $L_{\text{wot}}$ ,  $L_{\text{vehicle,expected}}$ ,  $a_{\text{WOT,test}}$ ,  $V_{\text{PP}}$ , gear ratio), the rows shall contain the sequential measurements (1,2,3...).

For easy evaluation, a graph may be used where the noise values are plotted as a function of vehicle speed. Measurements in different gear ratios shall be grouped together with specific colors or markings. The measurement result from annex 3  $L_{\text{urban}}$  shall be marked separately.

## 5. Noise limit

The difference between every individual measured noise level  $L_{\text{wot}}$  and its affiliated expected noise level  $L_{\text{vehicle,expected}}$  shall be not more than [2.0] dB(A):

$$L_{\text{delta}} = L_{\text{wot}} - L_{\text{vehicle,expected}} \leq [2.0] \text{ dB}$$

This margin takes into account acceptable resonances and scatter of individual measurements.