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| Submitted by the expert from OICAIn the context of the revision of the ASEP procedure | GRB IWG ASEP 1st Meeting 2016-11-07 in Tianjin, China |

**Proposals to clarify the 03 series of amendments of Regulation No. 51 (main body and annex 7)**

The proposed amendments to the current Regulation No. 51 are incorporated into the consolidated text and marked in bold for new or strikethrough for deleted characters.

 **I. Proposal**

*Paragraph 2.18.,* amend to read:

"2.18. **Gear** ~~"~~*~~Locked gear ratios~~*~~" means the control of transmission such that the transmission gear cannot change during a test.~~

**2.18.1. "*Gear*" means in the context of this Regulation a discrete gear ratio either selectable by the driver or by an external device.**

**2.18.2. "*Gear ratio*" means in the context of this Regulation any ratio between vehicle speed and engine speed during the passage of the vehicle through the test track. Most relevant is the gear ratio at the point in the test track, when the rear of the vehicle passes line BB’.**

**2.18.3.** "*Locked gear ratio~~s~~*" means the control of **the** transmission such that the ~~transmission~~ gear ~~cannot~~ **will not** change during a test.

  **Note: The common understanding of a "low gear" or a "high gear" shall not be applied to gear ratios. For example the lowest gear for forward driving, the first gear, has the highest gear ratio of all forward driving gears.**

**While manual transmission have discrete gears, many non-manual transmissions can have not only discrete gears in the classical understanding, but can have more gear ratios engaged by the control unit of the transmission.**

**2.18.4. "*geari*" and "*geari+1*" are defined as two gears in sequence, where geari provides an acceleration greater than awot\_ref, and geari+1 an acceleration lower than awot\_ref"**

*Insert new paragraph 2.25.*, to read:

**"2.25. Modes**

**2.25.1. "*Mode*" means a distinct driver-selectable condition which does affect the sound emission of the vehicle.**

**[2.25.2. "*Multi-mode*" means that more than one operating mode can be selected by the driver or automatically set.**

**2.25.3. "*Predominant mode*" for the purposes of this Regulation means a single mode that is always selected when the vehicle is switched on regardless of the operating mode selected when the vehicle was previously shut down. The predominant mode must not be able to be redefined. The switch of the predominant mode to another available mode after the vehicle being switched on shall only be possible by an intentional action of the driver.]"**

*Insert new paragraph 2.26.*, to read:

**"2.26. Stable Acceleration**

**2.26.1. "*Stable acceleration*" is a homogeneous constant acceleration within the test track area between line AA’ and BB’ plus the vehicle length.**

**2.26.2. "*Unstable acceleration*" means a deviation from the stable acceleration during acceleration.**

**2.26.2.1. Unstable acceleration might occur during the start of an acceleration from low speeds when the powertrain will react by bumping and jerking on the acceleration request.**

**2.26.2.2. Unstable acceleration exists when the acceleration of the vehicle is very non-linear and the proper acceleration to be related with the sound emission of the vehicle cannot be determined.**

**In the context of this Regulation such an unstable acceleration is given, when the acceleration between the PP’ line and the BB’ line is more than [xx] per cent higher compared to the acceleration between the AA’ line and the PP’ line.**

 **The acceleration between line AA’ and line PP’ is calculated by:**

 **aAA-PP = ((vPP’/3,6)² - (vAA’/3,6)²)/20**

 **where the speeds are given in km/h.**

 **The acceleration between line PP’ and line BB’ is performed according to the formulae given in Annex 3 under paragraph 3.1.2.1.2."**

*Annex 7*, amend to read:

"Annex 7

 Measuring method to evaluate compliance with the Additional Sound Emission Provisions

Only applicable for vehicles as specified in paragraph 6.2.3. of this Regulation

1. General

This annex describes a ~~measuring~~ **measurement** method to evaluate compliance of the vehicle with the additional sound emission provisions (ASEP) conforming to paragraph 6.2.3. of this Regulation.

It is not mandatory to perform actual tests when applying for type-approval. The manufacturer shall sign the declaration of compliance set out in Appendix 1. The approval authority may ask for additional information about the declaration of compliance and carry out the tests described below.

The procedure set out in this annex requires the performance of a test in accordance with Annex 3. The test specified in Annex 3 shall be carried out on the same test track ~~under conditions similar to those required in the tests prescribed in this annex~~ **intended for the measurements of this Annex 7 with the gears/gear ratios and weighting factors as during the type approval according to Annex 3, paragraph 2.2 until paragraph 3.1.3.1.**

2. ~~Measuring~~ **Measurement** method

2.1. ~~Measuring~~ **Measurement** instruments and condition o f measurements

Unless otherwise specified, the ~~measuring~~ **measurement** instruments, the conditions of the measurements and the condition of the vehicle are equivalent to those specified in Annex 3, paragraphs 1. and 2.

If the vehicle has different modes that affect sound emission, all modes shall comply with the requirements in this annex. In the case where the manufacturer has performed tests to prove to the approval authority compliance with the above requirements, the modes used during those tests shall be reported in a test report.

2.2. Method of testing

 Unless otherwise specified, the conditions and procedures of Annex 3~~,~~ ~~paragraphs 3.1. to 3.1.2.1.2.2.~~ shall be used. For the purpose of this annex, single test runs are measured and evaluated.

2.3. Control range

 Operation conditions are as follows:

Vehicle speed VAA\_ASEP: vAA ≥ 20 km/h

Vehicle acceleration aWOT\_ASEP: aWOT ≤ 5.0 m/s2

Engine speed nBB\_ASEP nBB ≤ 2.0 \* PMR-0.222 \* S or

 nBB ≤ 0.9 \* S, whichever is the lowest

 Vehicle speed VBB\_ASEP:

~~if n~~~~BB\_ASEP~~ ~~is reached in one gear v~~~~BB~~ ~~≤ 70 km/h~~

~~in all other cases v~~~~BB~~ ~~≤ 80 km/h~~

~~gears κ ≤ gear i as determined in Annex 3~~

~~If the vehicle, in the lowest valid gear, does not achieve the maximum engine speed below 70 km/h, the vehicle speed limit is 80 km/h.~~

**If nBB\_ASEP is reached in** **at least** **one valid gear** **below 80 km/h, the maximum** **vehicle speed is 70 km/h for all other valid gears.**

**If nBB\_ASEP cannot be reached in any valid gear below 80 km/h, the maximum vehicle speed is 80 km/h for all valid gears.**

**Valid gears: gear κ ≤ geari**

**Valid gear ratios: gear ratio χ ≥ gear ratio i**

**with geari as defined in paragraph 2.18. of this Regulation.**

2.4. Gear ratios

The ASEP requirements apply to every gear ~~ratio~~ κ **/ gear ratio χ** that leads to test results within the control range as defined in paragraph 2.3. of this annex.

In case of vehicles with automatic transmissions, adaptive transmissions and CVT's tested with non-locked **gear /** gear ratios, the test may include a **gear /** gear ratio change to a lower ~~range~~ **gear or a high gear ratio** and a higher acceleration. A **gear /** gear **ratio** change ~~to a higher range and a~~ **that results in a** lower acceleration is not allowed. A **gear /** gear **ratio** shift which leads to a condition that is not in compliance with the boundary conditions ~~shall~~ **should** be avoided. In such a case, it is permitted to establish and use electronic or mechanical devices, including alternat**iv**e gear selector positions.

2.5. Target conditions

The sound emission shall be measured in each valid gear ratio at the four test points as specified below. **For all test points the boundary conditions as specified in paragraph 2.3. shall be met.**

**The gear ratio is valid if all four points and the anchor point meet the specifications of paragraph 2.3.**

The first test point P1 is defined by using an entry **vehicle** speed ~~v~~~~AA~~ of 20 km/h **< vAA\_1 < 20 km/h +3 km/h.** If a stable acceleration cannot be achieved **according to paragraph 2.26.2.1. of this Regulation**, the vehicle speed **vAA** shall be increased in steps of 5 km/h until a stable acceleration is reached.

**In cases of an unstable acceleration according to paragraph 2.26.2.2. of the main body the acceleration between PP-BB shall be calculated and used for further processing.**

**In case of non-locked automatic transmission where nBB ASEP is exceeded during the test, the following measures shall be considered separately or together:**

* **provisions of paragraph 2.4.**
* **increase the vehicle speed in steps of 5 km/h.**

**The test vehicle speed for** **the** ~~The~~ fourth test point P4 **in any gear** is defined by ~~the maximum vehicle speed at BB' in that gear ratio within the boundary conditions according to paragraph 2.3.~~ **either:**

* **0,95 x n BB ASEP ≤ n BB\_4 ≤ n BB ASEP or**
* **vBB\_ASEP - 3 km/h ≤ vBB\_4 ≤ vBB\_ASEP with vBB\_ASEP as defined in paragraph 2.3.**

The **test vehicle speed of** **the** other two test points are defined by the following formula:

Test Point Pj: vBB\_j = vBB\_1 + ((j - 1) / 3) \* (vBB\_4 - vBB\_1) for j = 2 and 3 **with a tolerance of ± 3 km/h**

Where:

vBB\_1 = vehicle speed at BB' of test point P1

vBB\_4 = vehicle speed at BB' of test point P4

~~Tolerance for v~~~~BB\_j~~~~: ±3 km/h~~

~~For all test points the boundary conditions as specified in paragraph 2.3. shall be met.~~

2.6. Test of the vehicle

The path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test, starting from the approach **of the reference point according to paragraph 2.11. of the main body** to line AA' until the rear of the vehicle passes line BB'.

At line AA' the accelerator shall be fully depressed. To achieve a more stable acceleration or to avoid a down shift between line AA' and BB' pre-acceleration before line AA' may be used **according to the provisions of paragraphs 3.1.2.1.2.1. and 3.1.2.1.2.2**. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.

**Per test point, one single run is carried out.**

For every separate test run, the following parameters shall be determined and noted:

The maximum A-weighted sound pressure level of both sides of the vehicle, indicated during each passage of the vehicle between the two lines AA' and BB', shall be mathematically rounded to the first decimal place (Lwot,κj). 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 separately**. For further processing the higher sound pressure level of both sides is to be used.**

The vehicle speed readings at AA'**, PP’** and BB' shall be **rounded and** reported with the first significant digit after the decimal place. (vAA,κj; **, vPP,κj**; vBB,κj)

If applicable, the engine speed readings at ~~AA' and~~ BB' shall be reported as a full integer value ~~(n~~~~AA,κj~~~~; n~~~~BB,κj~~~~)~~.

The calculated acceleration shall be determined in accordance to the formula in paragraph 3.1.2.1.2. of Annex 3 and reported to the second digit after the decimal place (awot,test,κj).

3. ~~Analysis of results~~ **Analysis Method 1: Slope-Assessment**

3.1. Determination of the anchor point ~~for each gear ratio~~

**The anchor point is uniform for each gear ratio falling under the control range according to paragraph 2.3.** The anchor point consists of the ~~maximum~~ sound level Lwot**,rep,i**, the reported engine speed nwot,I ~~and vehicle speed v~~~~woti~~ at BB' of gear ratio i of the acceleration test in Annex 3.

Lanchor~~,κ~~ ~~= L~~~~woti,Annex 3~~ **isthe higher sound pressure level of Lwot,rep,i of left and right side**.

nanchor~~,κ~~ ~~= n~~~~BB,woti,Annex 3~~ **is the average of nBB,wot,i of the 4 runs reported from annex 3 at line BB’. of the acceleration test.**

vanchor~~,κ~~ ~~= v~~~~BB,woti,Annex 3~~ **is the average of vBB,wot,i of the 4 runs reported from annex 3 at line BB’ of the acceleration test**

3.2. Slope of the regression line for each gear **ratio κ**

The sound measurements shall be evaluated as function of engine speed according to paragraph 3.2.1.

3.2.1. Calculation of the slope of the regression line for each gear **ratio κ**

The linear regression line is calculated using the anchor point and the four correlated additional measurements **as specified under 2.5 above**.

  (in dB(A)/1,000 min-1)

 With  and  ;

 where nj = engine speed measured at line BB'

3.2.2. Slope of the regression line for each gear **ratio κ**

The slopeκ of a particular gear for the further calculation is the derived result of the calculation in paragraph 3.2.1. rounded to the first decimal place, but not higher than 5 dB(A)/1,000 min-1.

**In case of non-locked automatic transmission, if slopeκ  < 0, the selected transmission setup is not valid. In that case the Lurban-Assessment as specified in paragraph 6. shall be applied.**

3.3. Calculation of the linear sound level increase expected for each measurement

The sound level LASEP,κj for measurement point j and gear **ratio** κ shall be calculated using the engine speeds measured for each measurement point, using the slope specified in paragraph 3.2. above to the specific anchor point for each gear ratio.

For nBB\_κ,j ≤ nanchor,κ:

LASEP\_κ,j = Lanchor\_κ + (Slopeκ - Y) \* (nBB\_κ,j - nanchor,κ) / 1,000

For nBB\_κ,j > nanchor,κ:

LASEP\_κ,j = Lanchor\_κ + (Slopeκ + Y) \* (nBB\_κ,j - nanchor,κ) / 1,000

Where Y= 1

3.4. Samples

On request of the type approval authority two additional runs within the boundary conditions according to paragraph 2.3. of this annex shall be carried out.

4. ~~Interpretation of results~~ **Slope-Assessment- Specifications**

Every individual sound measurement shall be evaluated.

The sound level of every specified measurement point shall not exceed the limits given below:

Lκj ≤ LASEP\_κ.j + x

with:

x = 3 dB(A) **+ limit value - Lurban of Annex 3** for vehicle with a non-lockable automatic transmission or non-lockable CVT

x = 2 dB(A) + limit value - Lurban of Annex 3 for all other vehicles

If the measured sound level at a point exceeds the limit, two additional measurements at the same point shall be carried out to verify the measurement uncertainty. The vehicle is still in compliance with ASEP, if the average of the three valid measurements at this specific point fulfils the specification.

5. Reference sound assessment

~~The reference sound is assessed at a single point in one discrete gear, simulating an acceleration condition starting with an entry speed at v~~~~aa~~ ~~equal to 50 km/h and assuming an exit speed at v~~~~bb~~ ~~equal to 61 km/h. The sound compliance at this point can either be calculated using the results of paragraph 3.2.2. and the specification below or be evaluated by direct measurement using the gear as specified below.~~

**5.1.** **General**

**The reference sound can be obtained by simulation or from direct measurement. The result of one assessment method has to comply with the specification of paragraph 5.4.**

**5.1.1 Conditions for simulation**

**For simulation, the reference sound is assessed at a single point in one discrete gear, simulating an acceleration condition assuming an exit speed at vbb equal to 61 km/h. The sound compliance is calculated using the results of paragraph 3.2.2.**

**If the result of 3.2.2. is not available for the gear specified in paragraph 5.2, the slope of the missing gear can be determined according to paragraphs 2.5., 3.1. and 3.2.**

**5.1.2 Conditions for direct measurement**

**For direct measurement, the reference sound is assessed at a single run in an acceleration condition started at line AA as specified in paragraph 2.6. The gear shall be as specified in paragraph 5.2. for vehicles tested in locked position or in D for vehicles tested in non-locked position.**

**The target test speed vAA is equal to 50 km/h ± 1 km/h unless vBB exceeds 61 km/h.**

**If vBB exceeds 61 km/h, the target test speed vBB shall be set to 61 km/h ± 1 km/h. The entry speed shall be adjusted to achieve the target test speed.**

5.~~1.~~**2** The determination of gear κ is as follows:

κ = 3 for all manual transmission and for automatic transmission **tested in locked position** with up to 5 gears;

κ = 4 for automatic transmission **tested in locked position** with 6 or more gears, **unless the acceleration does not exceed [1.8 m/s²] in this gear. In that case a gear κ > 4 shall be chosen, so that an acceleration of [1.8 m/s²] is not exceeded.**

If no discrete gears are available, e.g. for non-lockable automatic transmissions or non-lockable CVTs, the gear ratio for further calculation shall be determined from the acceleration test result in Annex 3 using the reported engine speed and vehicle speed at line BB'.

5.~~2.~~**3 Data-processing for simulation assessment**

5.~~2.~~**3.1.** Determination of reference engine speed nref\_κ

The reference engine speed, nref\_κ, shall be calculated using the gear ratio of gear κ at the reference speed of vref = 61 km/h.

5.~~3.~~**3.2.** Calculation of Lref

Lref = Lanchor\_κ + Slopeκ \* (nref\_κ - nanchor\_κ) / 1,000

**5.4 Specifications**

**For vehicles of category M1,** Lref shall be less than or equal to 76 dB(A).

**For vehicles of category N1 with a technically permissible maximum laden mass below 2000 kg, Lref shall be less than or equal to 78 dB(A).**

**For vehicles of category N1 with a technically permissible maximum laden mass above 2000 kg and below 3500 kg, Lref shall be less than or equal to 79 dB(A).**

For vehicles fitted with a manual **transmission** ~~gear box~~ having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75, Lref shall be less than or equal to 79 dB(A).

For vehicles fitted with an automatic **transmission** ~~gear box~~ having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75, Lref shall be less than or equal to 78 dB(A).

**For the vehicle equipped with a compression-ignition and direct injection internal combustion engine, the sound level shall be increased by 1 dB(A).**

**For vehicle types designed for off-road use and with a technically permissible maximum laden mass above 2 tonnes, the sound level shall be increased by 1 dB(A) if they are equipped with an engine having a rated maximum net power of less than 150 kW (according to Regulation No. 85 ) or by 2 dB(A) if they are equipped with an engine having a rate maximum net power of 150 kW (according to Regulation No. 85) or above.**

6. ~~Evaluation of ASEP using the principle of L~~~~urban~~ **Analysis Method 2: Lurban-Assessment**

6.1. General

This evaluation procedure is an alternative selected by the vehicle manufacturer to the procedure described in paragraph 3. of this annex and is applicable for all vehicle technologies. It is the responsibility of the vehicle manufacturer to determine the correct manner of testing. Unless otherwise specified, all testing and calculation shall be as specified in Annex 3 to this Regulation.

**The measuring method is defined in paragraph 2. Each testing point shall be evaluated individually.**

6.2. Calculation of Lurban\_ASEP

**6.2.1 Data-processing**

From any Lwot\_ASEP as measured according to this annex, Lurban\_ASEP shall be calculated as follows:

(a) Calculate awot\_test\_ASEP using acceleration calculation from paragraph 3.1.2.1.2.1. or 3.1.2.1.2.2. of Annex 3 to this Regulation, as applicable;

(b) Determine the vehicle speed (vBB\_ASEP) at BB during the Lwot\_ASEP test;

(c) Calculate kP\_ASEP as follows:

kP\_ASEP = 1 - (aurban / awot\_test\_ASEP)

Test results where awot\_test\_ASEP are less than aurban shall be disregarded.

(d) Calculate Lurban\_measured\_ASEP as follows:

Lurban\_measured\_ ASEP = Lwot\_ASEP - kP\_ASEP \* (Lwot\_ASEP - L\_crs)

For further calculation, use the Lurban from Annex 3 to this Regulation without rounding, including the digit after the decimal (xx.x).

(e) Calculate Lurban\_normalized as follows:

Lurban\_normalized = Lurban\_measured\_ASEP - Lurban

(f) Calculate Lurban\_ASEP as follows:

Lurban\_ASEP = Lurban\_normalized - (0.15 \* (V\_BB\_ASEP - 50))

~~(g)~~

**6.2.2 Specifications**

Compliance with limits:

Lurban\_ASEP shall be less than or equal to 3.0 dB(A).

**Annex 7 – Appendix**

**Figure 1: Flowchart for the assessment concept for ASEP according to Annex 7**



**Figure 2: Flowchart for the vehicle sound assessment according to Annex 7 Paragraph 5. "Reference Sound Assessment"**

**Figure 3: Flowchart for the determination of the individual test points Pj according to paragraph 2.**

**"**

 **II. Justification**

There are several possibilities of misunderstanding and confusions which may induce different interpretations on application.