

**Economic and Social Council**Distr.: General
2 December 2016

Original: English

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations**Working Party on Noise****Sixty-fifth session**

Geneva, 15-17 February 2017

Item 4 (b) of the provisional agenda

Regulation No. 51 (Noise of M and N categories of vehicles):**Additional sound emission provisions****Proposal for Supplement 2 to the 03 series of amendments to
Regulation No. 51****Submitted by the Informal Working Group on Additional sound
emission provisions***

The text reproduced below was prepared by the Informal Working Group (IWG) on Additional sound emission provisions (ASEP) to update and revise the 03 series of amendments to Regulation No. 51. The proposed amendments to the current Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2016–2017 (ECE/TRANS/254, para. 159 and ECE/TRANS/2016/28/Add.1, cluster 3.2), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

GE.16-21289(E)



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I. Proposal

Paragraph 2.18., amend to read:

"2.18. **Gear**¹

2.18.1. "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. Use is the gear ratio at the point in the test track, when the rear of the vehicle passes line BB'.

2.18.2. "Locked gear ratios" means the control of the transmission such that the transmission gear cannot will not change during a test.

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

2.18.4. "Gear_i" and "gear_{i+1}" are defined as two gears in sequence, where gear_i provides an acceleration greater than the reference acceleration, and gear_{i+1} an acceleration lower than the reference acceleration.

When the acceleration meets the 5% tolerance of the reference acceleration, this gear is defined as well as "gear_i"."

Paragraph 2.24., amend to read:

"2.24. Table of symbols

<i>Symbol</i>	<i>Unit</i>	<i>Annex</i>	<i>Paragraph</i>	<i>Explanation</i>
...
V _{AA_ASEP}	km/h	Annex 7	2.3.	minimum vehicle speed at line AA' reported and used for calculations to the first decimal place
V _{BB_ASEP}	km/h	Annex 7	2.3.	maximum vehicle speed at line BB' AA' reported and used for calculations to the first decimal place
P _j	—	Annex 7	2.4. 5.	test point(s) under ASEP
j	—	Annex 7	2.4. 5.	index for the test points under ASEP
V _{BB_j}	km/h	Annex 7	2.4. 5.	vehicle test speed at BB' for a particular ASEP test point
a _{wot,test, κj}	m/s ²	Annex 7	2.5. 6.	acceleration at wide-open throttle achieved in gear κ and at test point j

¹ **Note: The common understanding of a "low gear" or a "high gear" shall not apply 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 has discrete gears, many non-manual transmissions can have more gear ratios engaged by the control unit of the transmission.**

<i>Symbol</i>	<i>Unit</i>	<i>Annex</i>	<i>Paragraph</i>	<i>Explanation</i>
$L_{wot,kj}$	dB(A)	Annex 7	2.5. 6.	sound pressure level measured for a gear κ and at a test point j; value to be reported and used for calculations to the first decimal place
$n_{BB,kj}$	1/min	Annex 7	2.5. 6.	vehicle test engine speed at BB' for a gear κ and at test point j
$V_{AA,kj}$	km/h	Annex 7	2.5. 6.	vehicle test speed at AA' for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
$V_{BB,kj}$	km/h	Annex 7	2.5. 6.	vehicle test speed at BB' for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
$V_{PP,kj}$	km/h	Annex 7	2.5.	vehicle test speed at PP' for a gear κ and at test point j; value to be reported and used for calculations to the first decimal place
$L_{anchor,\kappa}$	dB(A)	Annex 7	3.1.	reported vehicle sound pressure level for gear ratio i from Annex 3; value to be reported and used for calculations to the first decimal place
...
$L_{\kappa j}$	dB(A)	Annex 7	4. 3.5.	sound pressure level measured for a gear κ and at a test point j; value to be reported and used for calculations to the first decimal place
k_{P_ASEP}	—	Annex 7	6.2 4.2.1.	partial power factor determined for the L_{urban} principle of ASEP
L_{wot_ASEP}	dB(A)	Annex 7	6.2 4.2.1.	vehicle sound pressure level measured for the L_{urban} principle of ASEP; value to be reported and used for calculations to the first decimal place
$L_{urban_measured_ASEP}$	dB(A)	Annex 7	6.2 4.2.1.	interim result for calculation of L_{urban_ASEP}; value to be reported and used for calculations to the first decimal place
$L_{urban_normalized}$	dB(A)	Annex 7	6.2 4.2.1.	interim result for calculation of L_{urban_ASEP}; value to be reported and used for calculations to the first decimal place
ΔL_{urban_ASEP}	dB(A)	Annex 7	4.2.1.	estimated deviation from Urban sound pressure level; value to be reported to the first decimal place

<i>Symbol</i>	<i>Unit</i>	<i>Annex</i>	<i>Paragraph</i>	<i>Explanation</i>
α	—	Annex 7	5.2	gear to be determined for the reference sound assessment according to the type of transmission
L_{ref}	dB(A)	Annex 7	5.3.	reference sound pressure level for reference sound assessment; value to be reported and used for calculations to the first decimal place
.....				
V_{ref}	km/h	Annex 7	5.3.	reference vehicle test speed for reference sound assessment
k_{p_ASEP}	—	Annex 7	6.2.	partial power factor determined for the Lurban principle of ASEP
L_{wot_ASEP}	dB(A)	Annex 7	6.2.	vehicle sound pressure level measured for the Lurban principle of ASEP; value to be reported and used for calculations to the first decimal place
L_{urban_ASEP}	dB(A)	Annex 7	6.2.	Estimated urban sound pressure level determined for the Lurban principle of ASEP; value to be reported and used for calculations to the first decimal place
$L_{urban_measured_ASEP}$	dB(A)	Annex 7	6.2.	interim result for calculation of Lurban_ASEP; value to be reported and used for calculations to the first decimal place
$L_{urban_normalized}$	dB(A)	Annex 7	6.2.	interim result for calculation of Lurban_ASEP; value to be reported and used for calculations to the first decimal place

Insert a 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."

Insert a new paragraph 2.26., to read:

"2.26. Stable acceleration

2.26.1. "Stable acceleration" is given when the acceleration from line AA' to PP' has a low variation to the acceleration from line PP' to BB'.

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

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

Paragraph 6.2.3.3., amend to read:

"6.2.3.3. In applying for type approval, the manufacturer shall provide a statement, in conformity with ~~the~~ Appendix 1 of Annex 7, that the vehicle type to be approved complies with the requirements of paragraph 6.2.3. of this Regulation."

Annex 3, paragraph 3.1.2.1.4.1., amend to read:

"3.1.2.1.4.1. Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVTs tested with locked gear ratios

...

In the case of a vehicle not exempted from ASEP according to paragraph 6.2.3., gear i shall be tested and values reported ($L_{wot, i}$, $n_{wot, BB, i}$, $v_{wot, BB, i}$) in order to perform tests of Annex 7."

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.

If the tests according to Annex 7 are carried out in the course of type approval, all tests either for Annex 3 and for Annex 7 shall be carried out on the same test track² and, if possible, under similar environmental conditions.

If Annex 7 tests are carried out when type approval has already been granted, e.g. during tests for conformity of production or for in-use compliance, the test specified in Annex 3 shall be repeated with the same gears/gear ratios and weighting factors as determined during the type approval process.

² Measurements of Annex 3 and Annex 7 may be carried out on different test tracks if documentation exists that demonstrates that the differences in sound performance are neglectable.

~~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~~

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

2.1. ~~Measuring~~ **Measurement** instruments and condition of 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

The ASEP requirements apply to every gear ratio κ that leads to test results within the control range as defined below.

~~Operation conditions are as follows:~~

Vehicle speed V_{AA_ASEP} : $v_{AA} \geq 20$ km/h

Vehicle acceleration a_{WOT_ASEP} : $a_{WOT} \leq 5.0$ m/s²

Engine speed n_{BB_ASEP} $n_{BB} \leq 2.0 * PMR^{-0.222} * S$ or

$n_{BB} \leq 0.9 * S$, whichever is the lowest

Vehicle speed V_{BB_ASEP} :

~~if n_{BB_ASEP} is reached in one gear $v_{BB} \leq 70$ km/h~~

~~in all other cases $v_{BB} \leq 80$ km/h~~

~~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 the vehicle in the lowest valid gear does not achieve the maximum engine speed n_{BB_ASEP} below 70 km/h, ~~the vehicle speed limit is~~ **increase the vehicle speed in that gear to reach the maximum engine speed n_{BB_ASEP} , but not beyond 80 km/h.**

For any other gear, the maximum vehicle speed is 70 km/h.

For vehicles tested in non-locked transmission conditions, the maximum vehicle speed is 80 km/h.

Gears $\kappa \leq$ gear i as determined in Annex 3

<i>Annex 3 gear selection</i>	<i>Annex 7 gear selection</i>
Locked condition	Gear_i, gear_{i-1},...
Non-locked	Non-locked

2.4. Gear ratios

The ASEP requirements apply to every gear ratio κ 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 ratios, the test may include a gear ratio 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 shift which leads to a condition that is not in compliance with the boundary conditions **should** shall be avoided. In such a case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.~~

2.4.5. 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 P_1 is defined by using an entry speed $v_{AA,\kappa 1}$ of 20 km/h $\leq v_{AA,\kappa 1} < 20 \text{ km/h} + \pm 3 \text{ km/h}$. If a stable acceleration condition cannot be achieved **according to 2.26.2.1. in the definition section of this Regulation**, the speed $v_{AA,\kappa 1}$ shall be increased in steps of 5 km/h until a stable acceleration is reached.

In case of non-locked automatic transmission where n_{BB_ASEP} is exceeded during the test, the following measures shall be considered separately or together:

- **provisions of paragraph 2.5.1.**
- **increased speed in steps of 5 km/h.**

~~The fourth test point P_4 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:~~

- **$0.95 \times n_{BB_ASEP} \leq n_{BB,\kappa 4} \leq n_{BB_ASEP}$ or**
- **$v_{BB_ASEP} - 3 \text{ km/h} \leq v_{BB,\kappa 4} \leq v_{BB_ASEP}$ with v_{BB_ASEP} as defined in paragraph 2.3.**

~~The test speed for the other two test points is redefined by the following formula:~~

~~Test Point P_j : $v_{BB,\kappa j} = v_{BB,\kappa 1} + ((j - 1) / 3) * (v_{BB,\kappa 4} - v_{BB,\kappa 1})$ for $j = 2$ and 3 with a tolerance of $\pm 3 \text{ km/h}$~~

~~Where:~~

~~$v_{BB,\kappa 1}$ = vehicle speed at BB' of test point P_1~~

~~$v_{BB,\kappa 4}$ = vehicle speed at BB' of test point P_4~~

~~Tolerance for $v_{BB,j}$: $\pm 3 \text{ km/h}$~~

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

2.5.6. Test of the vehicle

2.5.1. 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 definition 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. of Annex 3**. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.

In case of vehicles with automatic transmissions, adaptive transmissions and CVT's tested with non-locked gear ratios, the test may include a gear ratio change to a lower range and a higher acceleration. A gear change to a higher range and a lower acceleration is not allowed. If possible, the manufacturer shall take the measures to avoid a gearshift which leads to a condition that is not in compliance with the boundary conditions. In such a case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

2.5.2. Measurements reading:

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 ($L_{wot,kj}$). 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 shall 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. ($v_{AA,kj}$; $v_{PP,kj}$; $v_{BB,kj}$)

If applicable, the engine speed readings at AA' and BB' shall be reported as a full integer value ($n_{AA,kj}$; $n_{BB,kj}$).

2.5.3. 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 ($a_{wot,test,kj}$).

3. ~~Analysis of results~~ **Analysis method 1: slope-assessment**

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

The anchor point is the same for each gear ratio κ falling under the control range according to paragraph 2.3. The parameters for the anchor point are taken from the acceleration test of Annex 3 as follows: consists of the maximum sound level $L_{wot,rep(i)}$, the reported engine speed $n_{wot,i}$ and vehicle speed $v_{wot,i}$ at BB' of gear ratio i of the acceleration test in Annex 3.

$L_{anchor,\kappa} = L_{wot,i,Annex\ 3}$ **is the higher sound pressure level of $L_{wot,(i)}$ of left and right side of gear ratio i ;**

$n_{\text{anchor},\kappa} = n_{\text{BB,wot,Annex 3}}$ is the average of $n_{\text{wot,BB},i}$ of the 4 runs of gear ratio i reported from Annex 3;

$v_{\text{anchor},\kappa} = v_{\text{BB,wot,Annex 3}}$ is the average of $v_{\text{wot,BB},i}$ of the 4 runs of gear ratio i reported from Annex 3.

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 **with the results for engine speeds and sound levels as reported under 2.5.2. of this annex.**

$$\text{Slope}_\kappa = \frac{\sum_{j=1}^5 (n_j - \bar{n})(L_j - \bar{L})}{\sum_{j=1}^5 (n_j - \bar{n})^2} \quad (\text{in dB(A)/1,000 min}^{-1})$$

$$\text{With } \bar{L} = \frac{1}{5} \sum_{j=1}^5 L_j \quad \text{and} \quad \bar{n} = \frac{1}{5} \sum_{j=1}^5 n_j ;$$

where n_j = engine speed measured at line BB'

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

The slope_κ 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 $\text{slope}_\kappa < 0$, the selected transmission setup is not valid. In that case the L_{urban} -assessment as specified in paragraph 4. shall be applied.

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

The sound level $L_{\text{ASEP},\kappa,j}$ 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 $n_{\text{BB},\kappa,j} \leq n_{\text{anchor},\kappa}$:

$$L_{\text{ASEP},\kappa,j} = L_{\text{anchor},\kappa} + (\text{Slope}_\kappa - Y) * (n_{\text{BB},\kappa,j} - n_{\text{anchor},\kappa}) / 1,000$$

For $n_{\text{BB},\kappa,j} > n_{\text{anchor},\kappa}$:

$$L_{\text{ASEP},\kappa,j} = L_{\text{anchor},\kappa} + (\text{Slope}_\kappa + Y) * (n_{\text{BB},\kappa,j} - n_{\text{anchor},\kappa}) / 1,000$$

Where $Y = 1$

3.4. **Additional 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.

4.3.5. Interpretation of results Specifications

Every individual sound measurement shall be evaluated.

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

$$L_{kj} \leq L_{ASEP_{kj}} + X$$

With:

$X = 3 \text{ dB(A)}$ [+ **limit value - L_{urban} of Annex 3**] for vehicle with a non-lockable automatic transmission or non-lockable CVT

$X = 2 \text{ dB(A)}$ + limit value - L_{urban} 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.

~~6.4.~~ Evaluation of ASEP using the principle of L_{urban} - **Analysis method 2: L_{urban} assessment**

~~6.4.1.~~ 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 measurement method is defined in paragraph 2. Each testing point shall be evaluated individually.

~~6.4.2.~~ Calculation of L_{urban_ASEP}

4.2.1. Data-processing

From any L_{wot_ASEP} as measured according to this annex, ΔL_{urban_ASEP} shall be calculated as follows:

(a) Calculate $a_{wot_test_ASEP}$ 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 (v_{BB_ASEP}) at BB during the L_{wot_ASEP} test;

(c) Calculate k_{P_ASEP} as follows:

$$k_{P_ASEP} = 1 - (a_{urban} / a_{wot_test_ASEP})$$

Test results where $a_{wot_test_ASEP}$ are less than a_{urban} shall be disregarded.

(d) Calculate $L_{urban_measured_ASEP}$ as follows:

$$L_{urban_measured_ASEP} = L_{wot_ASEP} \cdot k_{P_ASEP} * (L_{wot_ASEP} - L_{crs})$$

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

(e) Calculate $L_{urban_normalized}$ **to normalize the speed from v_{BB_ASEP} to 50 km/h** as follows:

$$L_{\text{urban_normalized}} = L_{\text{urban_measured_ASEP}} - L_{\text{urban}}$$

$$L_{\text{urban_normalized}} = L_{\text{urban_measured_ASEP}} - (0.15 * (V_{\text{BB_ASEP}} - 50))$$

- (f) Calculate the deviation $\Delta L_{\text{urban_ASEP}}$ relative to L_{urban} as follows:

$$L_{\text{urban_ASEP}} = L_{\text{urban_normalized}} + (0.15 * (V_{\text{BB_ASEP}} - 50))$$

$$\Delta L_{\text{urban_ASEP}} = L_{\text{urban_normalized}} - L_{\text{urban}}$$

4.2.2. Specifications

- (g) Compliance with limits:

$\Delta L_{\text{urban_ASEP}}$ shall be less than or equal to 3.0 dB(A) [+ limit value - L_{urban} of Annex 3].

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 5.4.

5.1.1. Conditions for simulation³

For simulation, the reference sound is assessed at a single point in one discrete gear, simulating an acceleration condition assuming an exit speed at v_{BB} 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 2.4., 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 2.5. The gear shall be as specified in paragraph 5.2. for vehicles tested in locked position or in a gear selected position for normal driving as specified by the manufacturer for vehicles tested in non-locked position.

The target test speed v_{AA} is equal to 50 km/h \pm 1 km/h unless v_{BB} exceeds 61 km/h.

If v_{BB} exceeds 61 km/h, the target test speed v_{BB} shall be set to 61 km/h \pm 1 km/h. The entry speed shall be adjusted to achieve the target test speed.

³ Simulation may not always be applicable as the test result of Annex 3 and the elaborated slopes according to paragraph 3. of Annex 7 might not provide consistent data for the simulation. In that case, it is recommended to carry out direct measurements.

5.2. The determination of gear α_{κ} is as follows:

$\alpha_{\kappa} = 3$ for all manual transmission and for automatic transmission **tested in locked position** with up to 5 gears;

$\alpha_{\kappa} = 4$ for automatic transmission **tested in locked position** with 6 or more gears. **If the acceleration calculated from AA to BB + vehicle length in gear 4 exceeds 1.9 m/s², the first higher gear $\alpha_{\kappa} > 4$ with an acceleration lower than or equal to 1.9 m/s² shall be chosen.**

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'.

5.3. Data-processing for simulation assessment

5.2.3.1. Determination of reference engine speed $n_{ref_a_{\kappa}}$

The reference engine speed, $n_{ref_a_{\kappa}}$, shall be calculated using the gear ratio of gear α_{κ} at the reference speed of $v_{ref} = 61$ km/h.

5.3.2. Calculation of L_{ref}

$$L_{ref} = L_{anchor_{\kappa}} + Slope_{a_{\kappa}} * (n_{ref_a_{\kappa}} - n_{anchor_{\kappa}}) / 1,000$$

5.4. Specifications

For vehicles of category M₁, L_{ref} shall be less than or equal to 76 dB(A).

For vehicles **of category M₁** 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, L_{ref} shall be less than or equal to 79 dB(A).

For vehicles **of category M₁** 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, L_{ref} shall be less than or equal to 78 dB(A).

For vehicles of category N₁ with a technically permissible maximum laden mass below 2,000 kg, L_{ref} shall be less than or equal to 78 dB(A).

For vehicles of category N₁ with a technically permissible maximum laden mass above 2,000 kg and below 3,500 kg, L_{ref} shall be less than or equal to 79 dB(A).

For vehicles of category M₁ and N₁ equipped with a compression-ignition and direct injection internal combustion engine, the sound level shall be increased by 1 dB(A).

For vehicles of category M₁ and N₁ 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}~~

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.~~

6.2. ~~Calculation of L_{urban_ASEP}~~

~~From any L_{wot_ASEP} as measured according to this annex, L_{urban_ASEP} shall be calculated as follows:~~

~~(a) Calculate $a_{wot_test_ASEP}$ 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 (v_{BB_ASEP}) at BB during the L_{wot_ASEP} test;~~

~~(c) Calculate k_{p_ASEP} as follows:~~

$$k_{p_ASEP} = 1 - (a_{urban} / a_{wot_test_ASEP})$$

~~Test results where $a_{wot_test_ASEP}$ are less than a_{urban} shall be disregarded.~~

~~(d) Calculate $L_{urban_measured_ASEP}$ as follows:~~

$$L_{urban_measured_ASEP} = L_{wot_ASEP} - k_{p_ASEP} * (L_{wot_ASEP} - L_{efs})$$

~~For further calculation, use the L_{urban} from Annex 3 to this Regulation without rounding, including the digit after the decimal (xx.x).~~

~~(e) Calculate $L_{urban_normalized}$ as follows:~~

$$L_{urban_normalized} = L_{urban_measured_ASEP} - L_{urban}$$

~~(f) Calculate L_{urban_ASEP} as follows:~~

$$L_{urban_ASEP} = L_{urban_normalized} - (0.15 * (V_{BB_ASEP} - 50))$$

~~(g) Compliance with limits:~~

~~L_{urban_ASEP} shall be less than or equal to 3.0 dB(A).~~

Annex 7 – Appendix 1

Statement of compliance with the additional sound emission provisions

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

..... (Name of manufacturer) attests that vehicles of this type (type with regard to its sound emission pursuant to Regulation No. 51) comply with the requirements of paragraph 6.2.3. of Regulation No. 51.

..... (Name of manufacturer) makes this statement in good faith, after having performed an appropriate evaluation of the sound emission performance of the vehicles.

Date:

Name of authorized representative:

Signature of authorized representative:

Annex 7 – Appendix 2

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

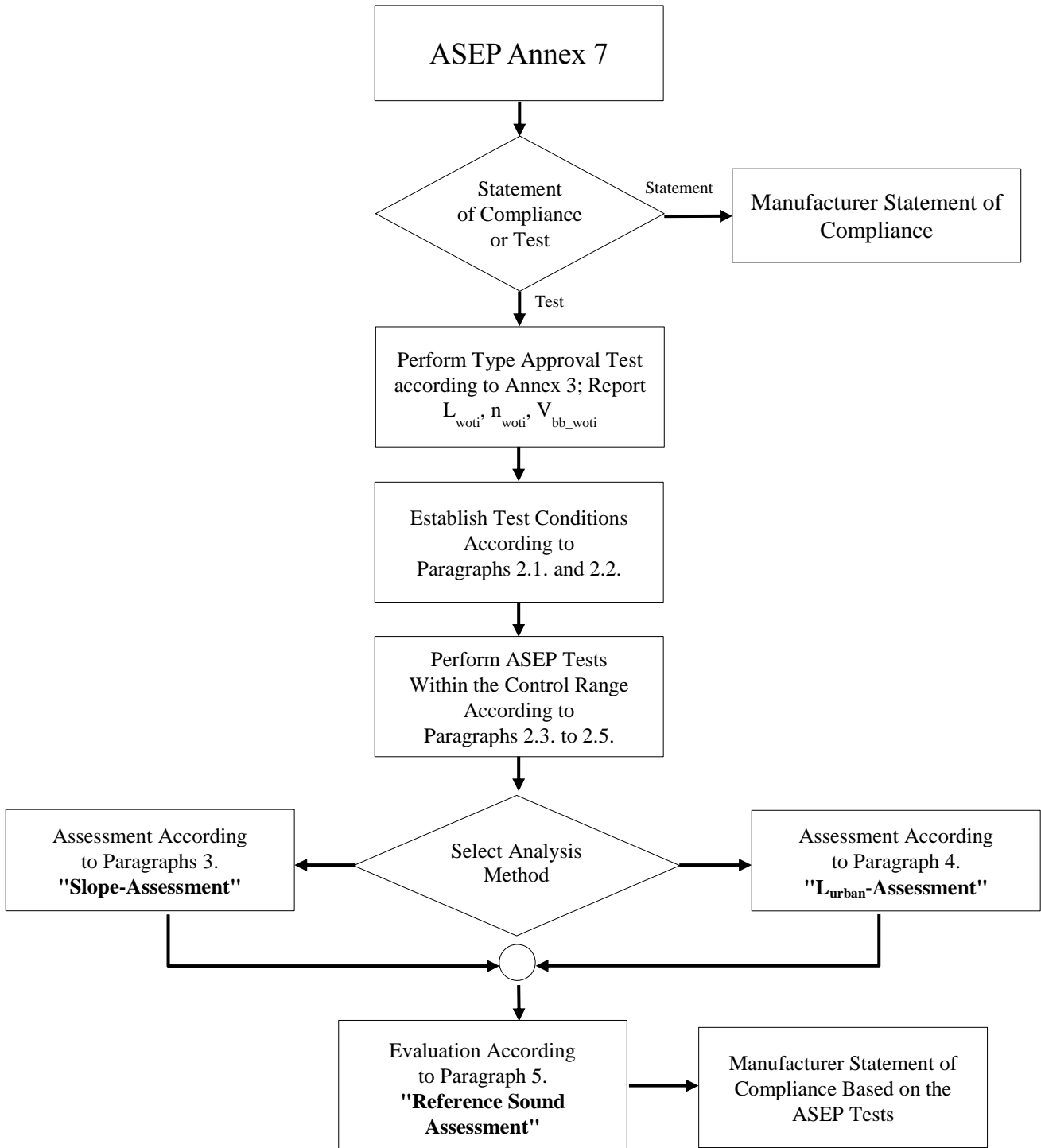


Figure 2
Flowchart for the vehicle sound assessment according to Annex 7, paragraph 5. "Reference sound assessment"

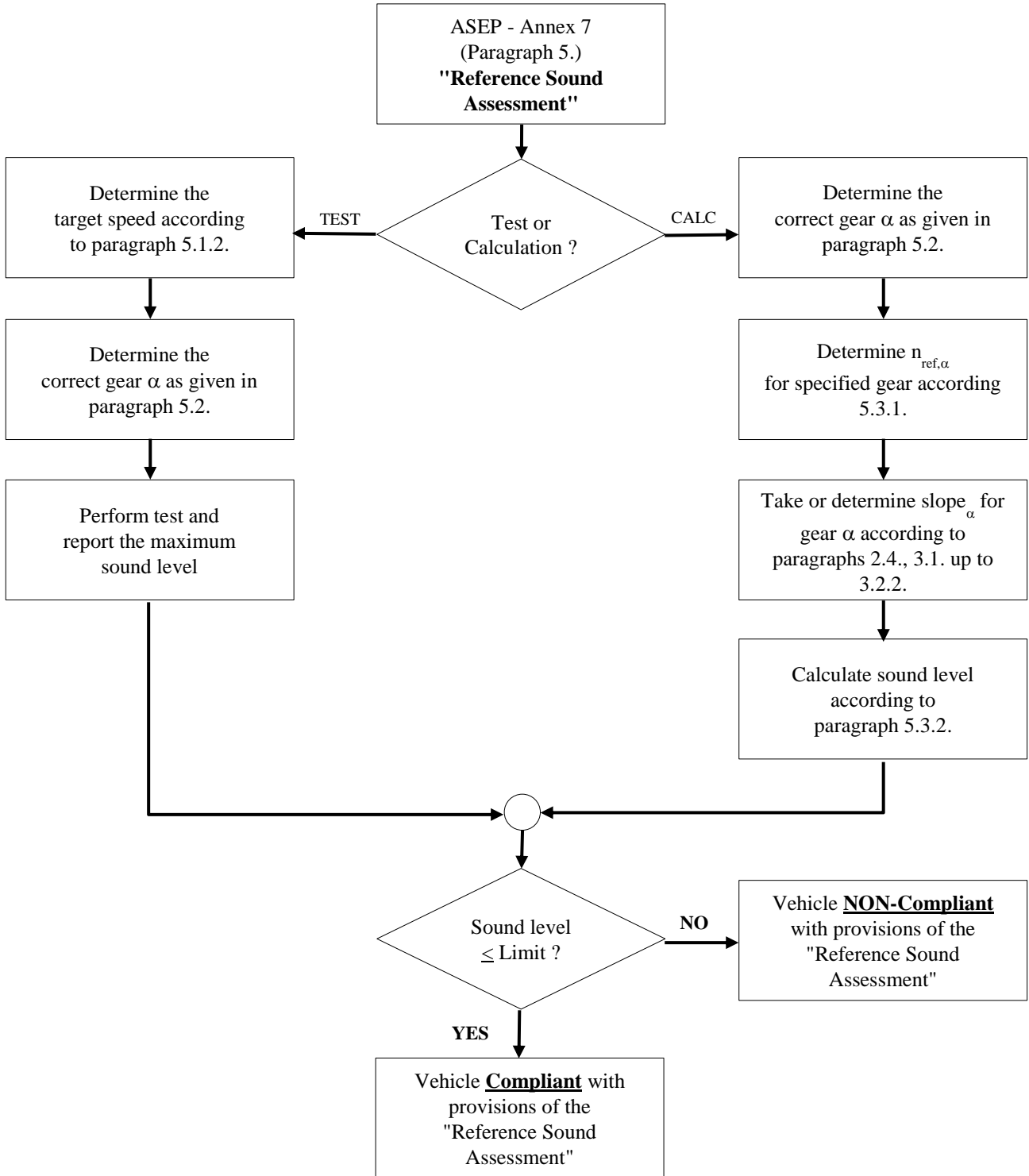
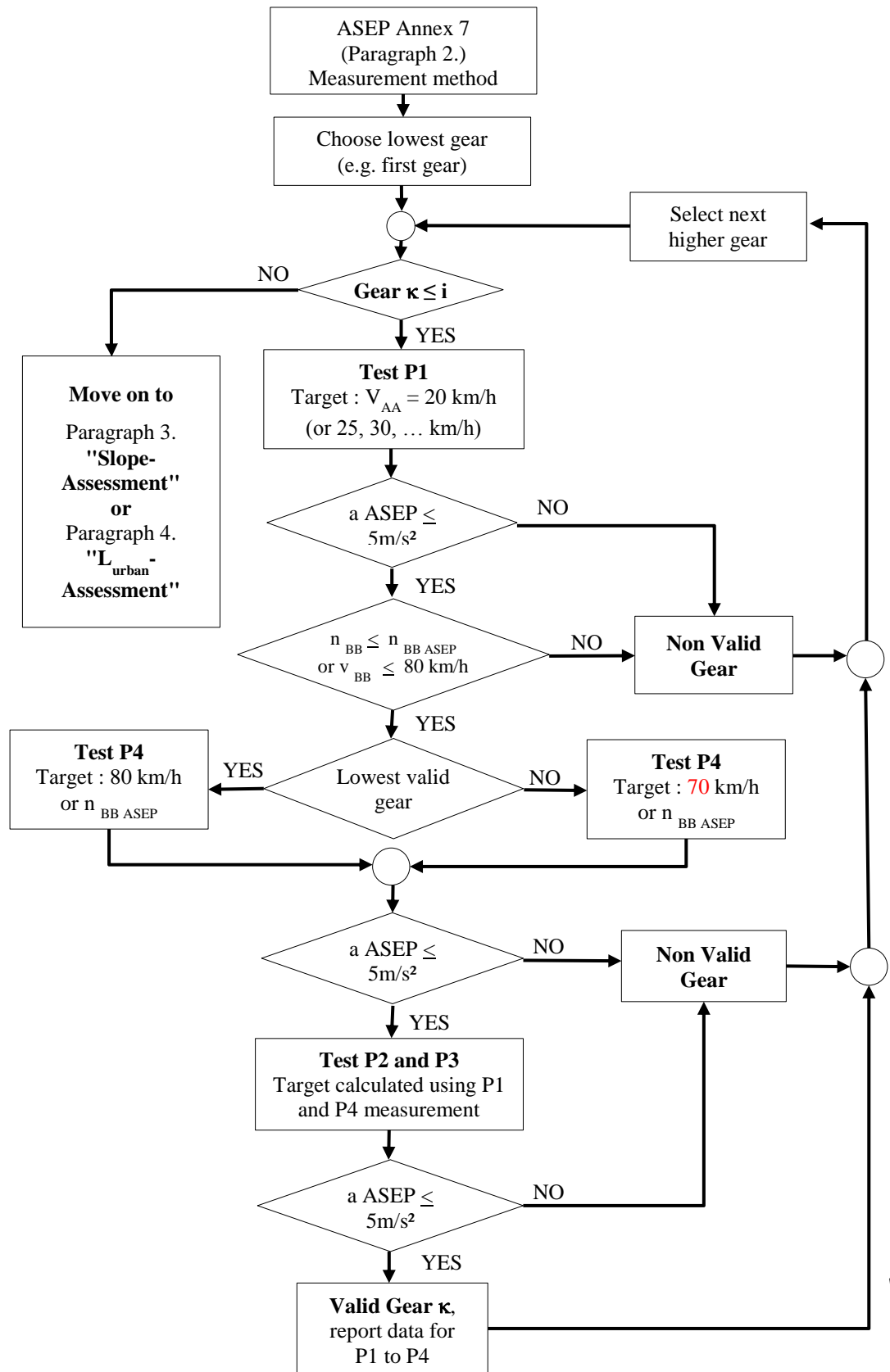


Figure 3
Flowchart for the determination of the individual test points P_j according to Annex 7, paragraph 2. "Measurement method"



II. Justification

1. In order to propose a testing procedure, which is more consistent and clearly defined, the following technical modifications and extensions were introduced.

1.1. New definitions for Annex 7, which are also applicable for Annex 3:

- (a) Definitions for gear, gear ratio, $gear_i$ and $gear_{i+1}$ were added for clarity;
- (b) The missing definition for mode was added and taken over from the first part of Global Technical Regulation No. 15;
- (c) Definitions for "Stable" and "Unstable" accelerations were introduced to avoid ambiguity.

1.2. The ambiguous principle of target speed 70 or 80 km/h was replaced by:

- (a) 80 km/h target speed (depending on n_{BB_ASEP}) for locked transmission for the lowest valid gear and non-locked transmission, to make sure that, at the lowest gear, the vehicle is tested closest to the requested maximum engine speed;
- (b) 70 km/h target speed was considered for all gears other than the lowest, as none of the higher gears can provide the maximum engine speeds higher than those achieved in the lowest gear.

1.3. Paragraph 2.4. was deleted. Its first part was moved to paragraph 2.3., as it contains the requirements for the control range. The second part was moved to paragraph 2.5.1., as it deals with the testing of the vehicle.

1.4. For the slope assessment, the "slope_κ < 0 on non-locked automatic transmission, the selected transmission setup not valid" was enhanced by the provision that, in this case, the L_{urban} - assessment shall be used. Otherwise, it would not be clear what should happen in this situation.

1.5. The paragraph was deleted. Its content was moved to paragraph 3., as it belonged to the slope assessment, which is now totally covered under paragraph 3.

1.6. In order to uniform the limit concept extra margin (limit value - L_{urban} of Annex 3) for "silent vehicle" defined in the slope assessment method for vehicles with locked transmission, this concept was also applied to vehicles with non-locked transmission and for the L_{urban} - assessment.

1.7. In order to be technology neutral and to respect the rapid changes in technology towards high gear number transmissions, an additional condition to determine the gear to be tested was introduced for reference sound assessment for automatic transmission tested in locked position with 6 or more gears. An acceleration of 1.9 m/s² was defined from 50 km/h at AA to 61 km/h at BB + 5 m length vehicle to reflect the typical type approval condition under the 02 series of amendments to Regulation No. 51.

1.8. The missing limits from the 02 series of amendments to Regulation No. 51 in the reference sound assessment were introduced:

- (a) For N_1 vehicles, the limits of the 02 series of amendments to Regulation No. 51 were overtaken and +2 dB(A) added, using the same principle already defined in the reference sound assessment for vehicles of category M_1 : for a category/sub-category, limit reference assessment equal to limit in the 02 series of amendments to Regulation No. 51 + 2 dB(A);
- (b) The tolerances of the 02 series of amendments to Regulation No. 51 for direct injection diesel and off-road vehicles.

- 1.9. The part on " L_{urban} - assessment" was moved before the reference sound assessment, to have the right order of assessment.
- 1.10. The conditions for direct measurement and simulation were separated and precised.
- 1.11. Speed normalization ($0.15 * (V_{\text{BB_ASEP}} - 50)$) was moved from $L_{\text{urban_ASEP}}$ to $L_{\text{urban_normalized}}$ and $L_{\text{urban_ASEP}}$ was renamed $\Delta L_{\text{urban_ASEP}}$.
- 1.12. Flowcharts were introduced.
2. To facilitate reading and understanding, the text was re-structured.
 - 2.1. Some paragraphs were renumbered.
 - 2.2. The sentences of paragraph 2.4. were moved to paragraphs 2.3. and 2.5.1.
 - 2.3. Some sentences were moved inside their parts.
 - 2.4. The reference assessment part was moved after the L_{urban} assessment part.
 - 2.5. The titles of several parts were changed.
3. In order to avoid misunderstanding and confusion which may induce different interpretations of application, the text was clarified.
 - 3.1. Editorial corrections were introduced ("measuring" replaced by "measurement", "gear box" instead of "transmission", etc.)
 - 3.2. References to paragraphs in the main body, Annex 3 and Annex 7 were introduced.
 - 3.3. Some explanations, notes and words were modified or introduced.
 - 3.4. The test conditions of Annex 7 compared to Annex 3 (track, environmental conditions, etc.) were made precise in order to take into account practical situations. A note was introduced.
 - 3.5. It was highlighted that "the gear ratio is valid if all four points and the anchor point meet the specifications of paragraph 2.3./boundary conditions".
 - 3.6. Tolerances for speed were applied on each test point (P1, P2, P3 and P4) and a tolerance for engine was introduced.
 - 3.7. Clarification was made about the non-locked automatic transmission where $n_{\text{BB_ASEP}}$ is exceeded during the test.
 - 3.8. A table for valid gears was introduced in Annex 7 regarding the Annex 3 gear selection.
 - 3.9. In case of non-locked automatic transmission where $n_{\text{BB_ASEP}}$ is exceeded during the test, additional measures were indicated to take into account some cases.
 - 3.10. Processing of the sound pressure level of both sides was added.
 - 3.11. The vehicle speed at PP and round rules were added.
 - 3.12. The anchor point's level, engine speed and speed was clarified in relation to Annex 3 results.
 - 3.13. For the reference sound assessment, gear α was introduced instead of κ to avoid confusion with the slope assessment.