

26 April 2018

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## **Agreement**

### **Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations\***

(Revision 3, including the amendments which entered into force on 14 September 2017)

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#### **Addendum 50 – UN Regulation No. 51**

#### **Revision 3 - Amendment 2**

Supplement 2 to the 03 series of amendments – Date of entry into force: 10 February 2018

#### **Uniform provisions concerning the approval of motor vehicles having at least four wheels with regard to their sound emissions**

This document is meant purely as documentation tool. The authentic and legal binding text is: ECE/TRANS/WP.29/2017/71.



**UNITED NATIONS**

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\* Former titles of the Agreement:

Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958 (original version); Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

Paragraph 2.18., amend to read:

- "2.18. Gear<sup>1</sup>
- 2.18.1. "Gear ratios"
- 2.18.1.1. "Internal gearbox ratio" means the ratios of engine to gearbox output shaft revolutions.
- 2.18.1.2. "Final drive ratio" means the ratio(s) of gearbox output shaft to driven wheel revolutions.
- 2.18.1.3. "Total gear ratio" means the ratios between vehicle speed and engine speed during the passage of the vehicle through the test track.
- 2.18.1.4. "Gear ratio" used in context with vehicles tested according to paragraph 3.1.2.1. of Annex 3 and Annex 7 is the total gear ratio as defined in paragraph 2.18.1.3. above.
- 2.18.2. "Locked gear ratio" means the control of the transmission such that the gear 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. For vehicles tested according to paragraph 3.1.2.1. of Annex 3 and Annex 7, "gear<sub>i</sub>" and "gear<sub>i+1</sub>" are defined as two gears in sequence, where gear<sub>i</sub> either provides an acceleration within the 5 per cent tolerance according to paragraph 3.1.2.1.4.1. (a) of Annex 3 or an acceleration greater than the reference acceleration, and gear<sub>i+1</sub> an acceleration lower than the reference acceleration according to paragraph 3.1.2.1.4.1. (b) or (c) of Annex 3.

<sup>1</sup> 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."

Paragraph 2.24., amend to read:

"2.24. Table of symbols

Symbol	Unit	Annex	Paragraph	Explanation
...	...	...	...	...
VAA'_ASEP	km/h	Annex 7	2.3.	Target vehicle velocity for test point P1 of the assessment method according paragraph 2.4
VBB'_ASEP	km/h	Annex 7	2.3.	Target vehicle velocity for test point P4 of the assessment method according paragraph 2.4
P <sub>j</sub>	—	Annex 7	2.4.	test point(s) under ASEP
j	—	Annex 7	2.4.	index for the test points under ASEP
VBB <sub>j</sub>	km/h	Annex 7	2.4.	vehicle test speed at BB' for a particular ASEP test point

<i>Symbol</i>	<i>Unit</i>	<i>Annex</i>	<i>Paragraph</i>	<i>Explanation</i>
$a_{wot, \kappa j}$	m/s <sup>2</sup>	Annex 7	2.5.	acceleration at wide-open throttle achieved in gear $\kappa$ and at test point $j$
$L_{wot, \kappa j}$	dB(A)	Annex 7	2.5.	sound pressure level measured for a gear $\kappa$ and at a test point $j$ ; value to be reported and used for calculations to the first decimal place
$n_{BB, \kappa j}$	l/min	Annex 7	2.5.	vehicle test engine speed at BB' for a gear $\kappa$ and at test point $j$
$v_{AA, \kappa j}$	km/h	Annex 7	2.5.	vehicle test speed at AA' for a gear $\kappa$ and at test point $j$ ; value to be reported and used for calculations to the first decimal place
$v_{BB, \kappa j}$	km/h	Annex 7	2.5.	vehicle test speed at BB' for a gear $\kappa$ and at test point $j$ ; value to be reported and used for calculations to the first decimal place
$v_{PP, \kappa j}$	km/h	Annex 7	2.5.	vehicle test speed at PP' for a gear $\kappa$ and at test point $j$ ; value to be reported and used for calculations to the first decimal place
$L_{anchor}$	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	3.5.	sound pressure level measured for a gear $\kappa$ and at a test point $j$ ; value to be reported and used for calculations to the first decimal place
$KP_{ASEP}$	—	Annex 7	4.2.1.	partial power factor determined for the $L_{urban}$ principle of ASEP
$L_{wot\_ASEP}$	dB(A)	Annex 7	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	4.2.1.	interim result for calculation of $\Delta L_{urban\_ASEP}$ ; value to be reported and used for calculations to the first decimal place
$L_{urban\_normalized}$	dB(A)	Annex 7	4.2.1.	interim result for calculation of $\Delta L_{urban\_ASEP}$ ; value to be reported and used for calculations to the first decimal place

<i>Symbol</i>	<i>Unit</i>	<i>Annex</i>	<i>Paragraph</i>	<i>Explanation</i>
$\Delta L_{urban\_ASEP}$	dB(A)	Annex 7	4.2.1.	estimated deviation from urban sound pressure level; value to be reported to the first decimal place
$\alpha$	—	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
...	...	...	...	...
$n_{BB\_ref}$	l/min	Annex 7	5.3.	Reference vehicle test engine speed for reference sound assessment
$V_{BB\_ref}$	km/h	Annex 7	5.3.	reference vehicle test speed for reference sound assessment*

\* All subsequent rows of the table are being deleted (*note by the secretariat*)."

*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" applicable when acceleration needs to be calculated is given when the acceleration ratio between  $a_{wot\_testPP-BB}$  and  $a_{wot\_test}$  is less than or equal to 1.2.

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 6.2.2., amend to read:*

"6.2.2. Sound level limits

The sound level measured in accordance with the provisions of paragraph 3.1. of Annex 3 to this Regulation, mathematically rounded to the nearest integer value, shall not exceed the following limits:

..."

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 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 (see the flowchart in Appendix 2, Figure 1)

This annex describes a 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 track and under similar environmental conditions.<sup>1</sup>

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 tests in motion specified in Annex 3 shall be carried out with the same mode, gear(s)/gear ratio(s), gear weighting factor  $k$  and partial power factor  $k_P$  as determined during the type approval process.

2. Measurement method (see the flowchart in Appendix 2, Figure 3)

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<sup>1</sup> Measurements for Annex 7 for a particular vehicle type may be carried out on a different test tracks or under different environmental conditions, each according to the provisions of this Regulation, if the test results  $L_{woti}$  and  $L_{crsi}$  for the gear  $i$ , representing the anchor point, do not differ by more the +/- 1.0 dB from the test results at the time when the tests according to Annex 3 have been carried out.

2.1. Measurement instruments and condition of measurements

Unless otherwise specified, the 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 which 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 shall be used. For the purpose of this annex, one run per test condition is measured and evaluated.

2.3. Control range

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

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

Vehicle acceleration  $a_{WOT\_ASEP}$ :  $a_{WOT} \leq 5.0 \text{ m/s}^2$

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 the vehicle in the lowest valid gear does not achieve the maximum engine speed  $n_{BB\_ASEP}$  below 70 km/h, 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  $\kappa \leq \text{gear } i$  as determined in Annex 3

Transmission conditions:

<i>Annex 3 gear selection</i>	<i>Annex 7 gear selection</i>
Locked	Gear <sub>i</sub> , gear <sub>i-1</sub> ,...
Non-locked	Non-locked

2.4. 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. above. Any gear ratio for which this criteria is not fulfilled is invalid and not analysed further.

The first test point  $P_1$  is defined by using an entry speed  $v_{AA,k1}$  of  $20 \text{ km/h} \leq v_{AA,k1} < 20 \text{ km/h} + 3 \text{ km/h}$ .

For  $P_1$ , if a stable acceleration condition cannot be achieved according to 2.26.2.1. in the definition section of this Regulation, the speed  $v_{AA,k1}$  shall be increased in steps of 5 km/h until a stable acceleration is reached.

For all points, if a stable acceleration condition cannot be achieved according to 2.26.1. the acceleration  $a_{\text{wot\_testPP-BB}}$  shall be calculated according the formula given in paragraph 3.1.2.1.2 of Annex 3.

In case of non-locked transmission conditions where  $n_{\text{BB\_ASEP}}$  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 test speed for the fourth test point  $P_4$  in any gear is defined by either

- $0.95 \times n_{\text{BB\_ASEP}} \leq n_{\text{BB},k4} \leq n_{\text{BB\_ASEP}}$  OR
- $v_{\text{BB\_ASEP}} - 3 \text{ km/h} \leq v_{\text{BB},k4} \leq v_{\text{BB\_ASEP}}$  with  $v_{\text{BB\_ASEP}}$  as defined in paragraph 2.3.

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

Test Point  $P_j$ :  $v_{\text{BB},kj} = v_{\text{BB},k1} + ((j - 1) / 3) * (v_{\text{BB},k4} - v_{\text{BB},k1})$  for  $j = 2$  and  $3$  with a tolerance of  $\pm 3 \text{ km/h}$

Where:

$v_{\text{BB},k1}$  = vehicle speed at BB' of test point  $P_1$

$v_{\text{BB},k4}$  = vehicle speed at BB' of test point  $P_4$

## 2.5. 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 downshift 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 non-locked transmission conditions, 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 measures to avoid that a gearshift leads to a condition not in compliance with the boundary conditions. For that, it is permitted to establish and use electronic or mechanical devices, such as alternate gear selector positions. If no such measures can be applied, the rationale shall be provided and documented in the technical report.

## 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 BB' shall be reported as a full integer value ( $n_{BB,kj}$ ).

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 method 1: Slope-Assessment

3.1. Determination of the anchor point

The anchor point is the same for each gear ratio  $\kappa$  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:

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

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

3.2. Slope of the regression line for each gear ratio  $\kappa$

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  $\kappa$

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.

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

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

where  $n_j$  = engine speed measured at line BB'



3.2.2. Slope of the regression line for each gear ratio  $\kappa$

The slope $_{\kappa}$  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<sup>-1</sup>.

In case of non-locked conditions, if 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  $L_{ASEP,\kappa,j}$  for measurement point  $j$  and gear ratio  $\kappa$  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  $n_{BB,\kappa,j} \leq n_{anchor}$ :

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

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

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

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.

3.5. Specifications

Every individual sound measurement shall be evaluated.

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

$$L_{kj} \leq L_{ASEP,\kappa,j} + X$$

With:

$$x = 3 \text{ dB(A)} + \text{limit value}^2 - L_{urban} \text{ for vehicle tested with non-locked transmission conditions}$$

$$x = 2 \text{ dB(A)} + \text{limit value}^2 - L_{urban} \text{ for vehicles tested with locked transmission conditions}$$

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.

4. Analysis method 2:  $L_{urban}$  Assessment

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

<sup>2</sup> As applicable for the approved type of 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.

4.2. Calculation of  $\Delta L_{\text{urban\_ASEP}}$

4.2.1. Data-processing

From any  $L_{\text{wot\_ASEP}}$  as measured according to this annex,  $\Delta L_{\text{urban\_ASEP}}$  shall be calculated as follows:

- (a) Calculate  $a_{\text{wot\_test\_ASEP}}$  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 ( $v_{\text{BB\_ASEP}}$ ) at BB during the  $L_{\text{wot\_ASEP}}$  test;
- (c) Calculate  $k_{\text{P\_ASEP}}$  as follows:

$$k_{\text{P\_ASEP}} = 1 - (a_{\text{urban}} / a_{\text{wot\_test\_ASEP}})$$

Test results where  $a_{\text{wot\_test\_ASEP}}$  are less than  $a_{\text{urban}}$  shall be disregarded.

- (d) Calculate  $L_{\text{urban\_measured\_ASEP}}$  as follows:

$$L_{\text{urban\_measured\_ASEP}} = L_{\text{wot\_ASEP}} - k_{\text{P\_ASEP}} * (L_{\text{wot\_ASEP}} - L_{\text{crs rep}})$$

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

- (e) Calculate  $L_{\text{urban\_normalized}}$  to normalize the speed from  $v_{\text{BB\_ASEP}}$  to 50 km/h as follows:

$$L_{\text{urban\_normalized}} = L_{\text{urban\_measured\_ASEP}} - (0.15 * (v_{\text{BB\_ASEP}} - 50))$$

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

$$\Delta L_{\text{urban\_ASEP}} = L_{\text{urban\_normalized}} - L_{\text{urban}}$$

4.2.2. Specifications

Compliance with limits:

$\Delta L_{\text{urban\_ASEP}}$  shall be less than or equal to  $3.0 \text{ dB(A)} + \text{limit value}^3 - L_{\text{urban}}$ .

5. Reference sound assessment (see the flowchart in Appendix 2, Figure 2)

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.

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<sup>3</sup> As applicable for the approved type of vehicle

- 5.1.1. Simulation method<sup>4</sup>
- For simulation, the reference sound is assessed at a single point in one discrete gear, simulating an acceleration condition assuming an exit speed  $v_{BB'}$  equal to 61 km/h. The sound compliance is calculated using the slope results of paragraph 3.2.2.
- If the result of slope of 3.2.2. is not available for the gear specified in paragraph 5.2, this slope of the missing gear can be determined according to paragraphs 2.4., 3.1. and 3.2.
- 5.1.2. Direct measurement method
- 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 condition or in a gear selected position for normal driving as specified by the manufacturer for vehicles tested in non-locked condition.
- 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.
- 5.2. The determination of gear  $\alpha$  is as follows:
- $\alpha = 3$  for all manual transmission and for automatic transmission tested in locked position with up to 5 gears;
- $\alpha = 4$  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/s<sup>2</sup>, the first higher gear  $\alpha > 4$  with an acceleration lower than or equal to 1.9 m/s<sup>2</sup> shall be chosen.
- For vehicles tested under non-locked condition, 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
- 5.3.1. Determination of reference engine speed  $n_{BB',ref,\alpha}$
- The reference engine speed,  $n_{BB',ref,\alpha}$ , shall be calculated using the gear ratio of gear  $\alpha$  at the reference speed of  $v_{BB',ref} = 61$  km/h.
- 5.3.2. Calculation of  $L_{ref}$
- $$L_{ref} = L_{anchor} + Slope_{\alpha} * (n_{BB',ref,\alpha} - n_{anchor}) / 1,000$$
- 5.4. Specifications
- For vehicles of category M<sub>1</sub>,  $L_{ref}$  shall be less than or equal to 76 dB(A).
- For vehicles of category M<sub>1</sub> fitted with a manual transmission having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to UN Regulation No.

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<sup>4</sup> 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.

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  $M_1$  fitted with an automatic transmission having more than four forward gears and equipped with an engine developing a rated maximum net power greater than 140 kW (according to UN 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  $N_1$  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  $N_1$  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  $M_1$  and  $N_1$  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  $M_1$  and  $N_1$  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 UN Regulation No. 85) or by 2 dB(A) if they are equipped with an engine having a rated maximum net power of 150 kW (according to UN Regulation No. 85) or higher.

## 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 UN Regulation No. 51) comply with the requirements of paragraph 6.2.3. of UN 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

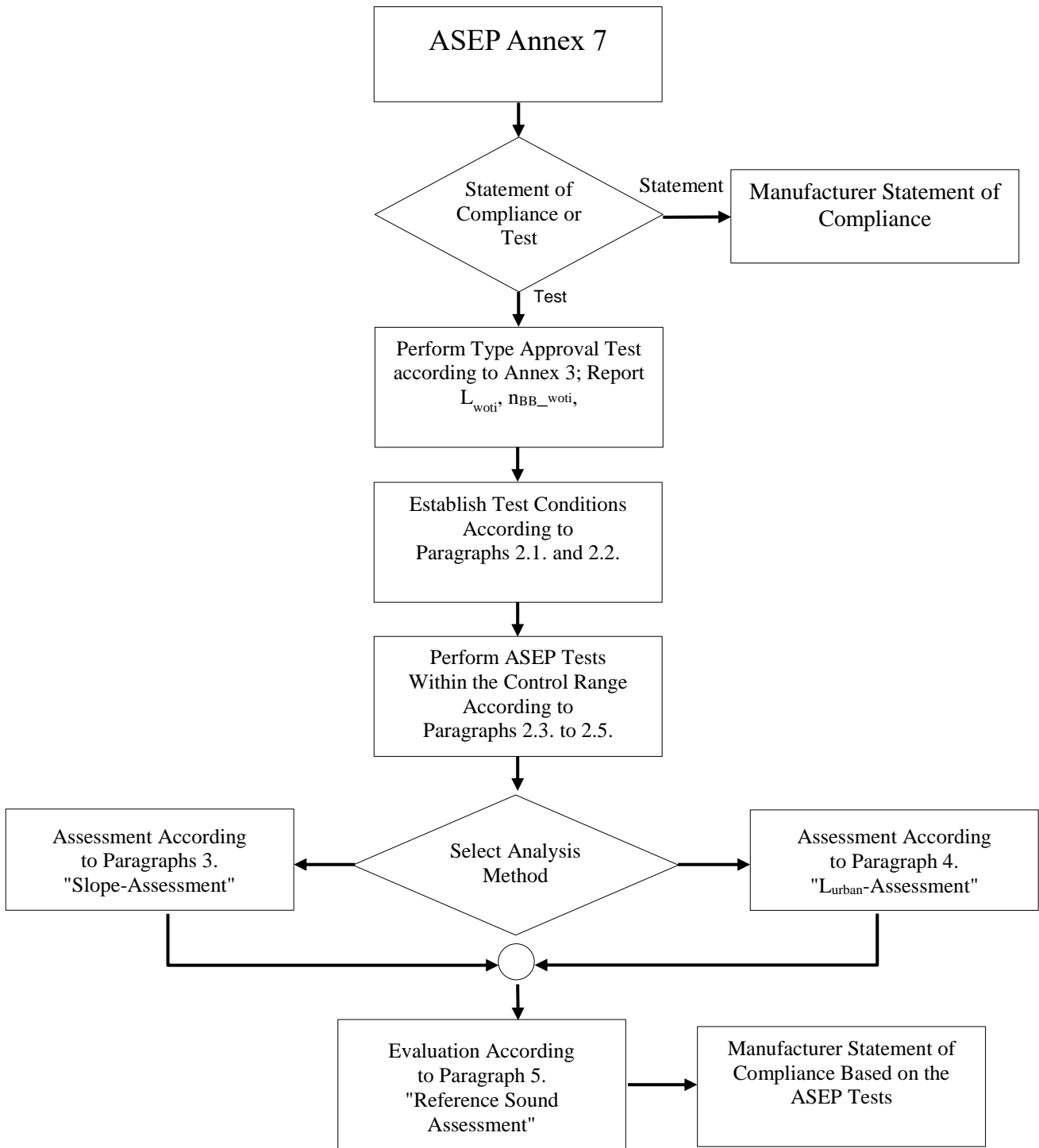


Figure 2  
**Flowchart for the vehicle sound assessment according to Annex 7, paragraph 5. "Reference sound assessment"**

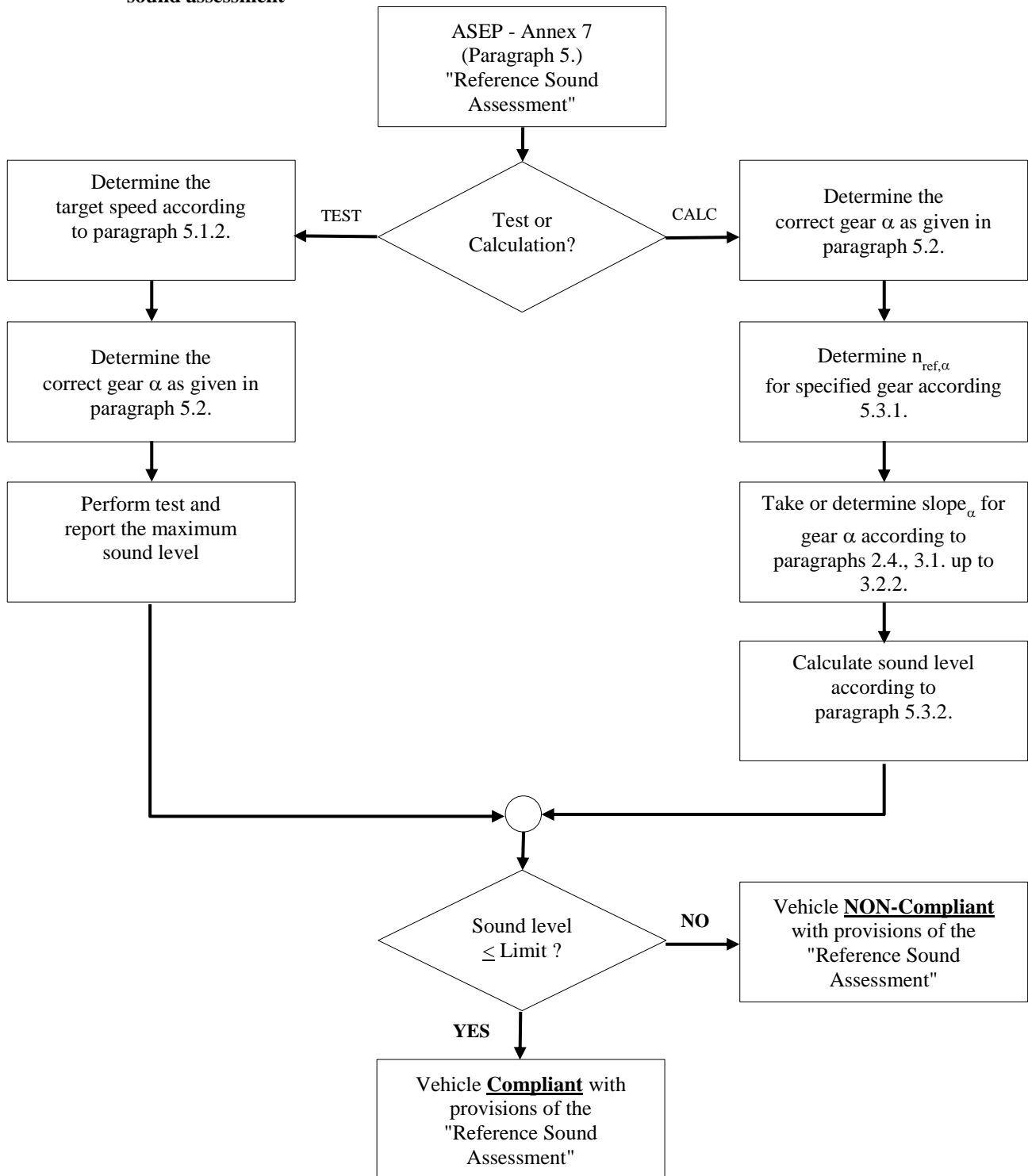


Figure 3  
 Flowchart for the determination of the individual test points  $P_j$  according to Annex 7, paragraph 2. "Measurement method"

