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Item 3(c) of the provisional agenda

Regulation No. 51 (Noise of M and N categories of vehicles) – Additional sound emission provisions

Proposal for draft amendments to Regulation No. 51

Submitted by the expert from the Netherlands *

The text reproduced below was prepared by the expert from the Netherlands to introduce Additional Sound Emission Provisions (ASEP) into Regulation No. 51. The proposal is based on ECE/TRANS/WP.29/GRB/2009/5. Modifications to the current text of the 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 2006–2010 (ECE/TRANS/166/Add.1, programme activity 02.4), 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.

I. Proposal

Insert a new paragraph 2.19., to read:

"2.19. "A defeat device" is any operational strategy or design feature whose purpose is to artificially reduce the sound emission within, or artificially increase sound emission outside, the test conditions as laid down in this Regulation."

Insert new paragraphs 6.2.3. to 6.2.3.4., to read

"6.2.3. Additional sound emission provisions

6.2.3.1. Scope and exemptions *

The additional sound emission provisions (ASEP) are preventive requirements. The purpose of these requirements is to ensure that the sound emission of the vehicle under typical driving conditions different from the conditions of the type approval test in Annex 3 shall not deviate considerably from the expected results according to the Annex 3 test for this specific vehicle.

The additional sound emission provisions apply only to vehicles of categories M₁ and N₁ equipped with an internal combustion engine.

Vehicles are deemed to fulfil the requirements of Annex 10, if the vehicle manufacturer provides technical documents to the type approval authority showing, that the difference between maximum and minimum of the vehicles engine speed at BB' for any test condition inside the ASEP control range defined in paragraph 3.3. of Annex 10 to this Regulation (including Annex 3 conditions) does not exceed 0.15 x S. This article is intended especially for non-lockable transmissions with variable gear ratios (CVT).

It is not applicable:

- (a) For vehicles of category N₁ with a gross vehicle weight (GVW) > 2.5 t with:**
 - (i) The driver position "R-point"¹ either forward of the front axle or longitudinally rearwards of the front axle transverse centreline by a maximum of [1150] mm, and**
 - (ii) The highest reported engine speed in the Annex 3 test ≥ [??] percent of S.**
- (b) For vehicles of category N₁ with a GVW ≤ 2.5 t with:**
 - (i) Payload ≥ 850 kg and PMR ≤ 40 kW/t, or**

* The text in paragraph 6.2.3.1. contains several options to exclude certain vehicles from ASEP as they were discussed in the informal group on ASEP (N₁, CVT, hybrid). This text may need fine tuning and discussion in GRB as it was not yet agreed upon in the ASEP informal group.

¹ Note by the secretariat:

Either a definition for the "R-point" should be inserted under paragraph 2. above or a reference to a UNECE Regulation including the definition or, if appropriate, to the Consolidated Resolution on the Construction of Vehicles (R.E.3).

- (ii) An engine capacity up to 660 cm³ and a PMR \leq 35 kW/t, or
 - (iii) The highest reported engine in the Annex 3 \geq 90 percent of the control range as defined in the control range of Annex 10.
- (c) For vehicles with a hybrid drive train which have an internal combustion engine with no mechanical coupling to the power train, which are excluded from ASEP for a period of five years after entering into force of this Regulation.
- 6.2.3.2. Defeat devices and cycle detection
- 6.2.3.2.1. [Defeat devices are not permitted]
- 6.2.3.2.2. [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] [over the speed range of the vehicle]. These measures are commonly referred to as "cycle detection".]
- 6.2.3.3. The vehicle shall meet the requirements of Annex 10 to this Regulation.
- 6.2.3.4. In the application for type approval the manufacturer shall provide a statement (in conformity with Appendix 1 of Annex 10) that the vehicle type to be approved complies with the requirements of paragraph 6.2.3. of this Regulation."

Paragraphs 8. to 8.3., amend to read:

"8. Conformity of production

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2) with the following requirements:

- 8.1. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 6. above. The limit values set forth in paragraph 6. and referenced appendices apply with an additional margin of 1 dB(A).
- 8.2. The minimum requirements for conformity of production control procedures set forth in Annex 7 to this Regulation shall be complied with.
- 8.3. The authority which has granted type approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be one every two years."

Paragraphs 8.3.1. to 8.4.5., should be deleted.

Annex 3, should be replaced by (former) Annex 10 amended as follows:

"Annex 3

Methods and instruments for measuring the noise made by motor vehicles

...

3.1.2.1.4.1. Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVT's tested with locked gear ratios

The following conditions for selection of gear ratios are possible:

- (a) If one specific gear ratio gives an acceleration in a tolerance band of ± 5 percent of the reference acceleration $a_{\text{wot ref}}$, ~~not exceeding 2.0 m/s^2~~ , test with that gear ratio.
- (b) If none of the gear ratios give the required acceleration, then choose a gear ratio i , with an acceleration higher and a gear ratio $i+1$, with an acceleration lower than the reference acceleration. ~~If the acceleration value in gear ratio i does not exceed 2.0 m/s^2 , use both gear ratios for the test.~~ The weighting ratio in relation to the reference acceleration $a_{\text{wot ref}}$ is calculated by:

$$k = (a_{\text{wot ref}} - a_{\text{wot (i+1)}}) / (a_{\text{wot (i)}} - a_{\text{wot (i+1)}})$$

- ~~(c) if the acceleration value of gear ratio i exceeds 2.0 m/s^2 , the first gear ratio shall be used that gives an acceleration below 2.0 m/s^2 unless gear ratio $i+1$ provides acceleration less than a_{urban} . In this case, two gears, i and $i+1$ shall be used, including the gear i with acceleration exceeding 2.0 m/s^2 . In other cases, no other gear shall be used. The achieved acceleration $a_{\text{wot test}}$ during the test shall be used for the calculation of the part power factor k_p instead of $a_{\text{wot ref}}$.~~
- (~~c~~) If the vehicle has a transmission in which there is only one selection for the gear ratio the acceleration test is carried out in this vehicle gear selection. The achieved acceleration is then used for the calculation of the part power factor k_p instead of $a_{\text{wot ref}}$.
- (~~d~~) If rated engine speed is exceeded in a gear ratio before the vehicle passes BB' the next higher gear shall be used.

3.1.2.1.4.2. Vehicles with automatic transmission, adaptive transmissions and CVT's tested with non-locked gear ratios:

The gear selector position for full automatic operation shall be used.

The acceleration value $a_{\text{wot test}}$ shall be calculated as defined in paragraph 3.1.2.1.2.2.

The test may then 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 is not used in urban traffic shall be avoided.

Therefore, 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 is typically not used at the specified test condition in urban traffic.

The achieved acceleration $a_{\text{wot test}}$ shall be greater or equal to a_{urban} .

~~If possible, the manufacturer shall take measures to avoid an acceleration value $a_{\text{wot test}}$ greater than 2.0 m/s^2 .~~

The achieved acceleration $a_{\text{wot test}}$ is then used for the calculation of the partial power factor k_p (see paragraph 3.1.2.1.3.) instead $a_{\text{wot ref}}$.

..."

Annex 7, paragraphs 1. to 3., amend to read:

"1. General

These requirements are consistent with the test to be held to check conformity of production according to paragraphs ~~8.3.5. and 8.4.3.~~ 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 ~~noise sound~~ of vehicle in motion as described in paragraph 3.1. of Annex 3.

2.2. Compressed air ~~noise 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 ~~noise sound~~ as described in paragraph 1. of Annex 6.

2.3. **Additional sound emission provisions**

The vehicle manufacturer shall assess the compliance with ASEP by an appropriate evaluation (for example, but not limited to, part checks) or may perform the test described in Annex 10.

3. Sampling and evaluation of the results

~~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. and subjected to the tests of paragraph 2. above. If the test results fulfil the COP requirements of paragraph 8. of the main body of this Regulation, the vehicle is considered to be in compliance with the COP provisions.~~

If one of the test results does not fulfil the COP requirements of paragraph 8. of the main body of this Regulation two more vehicles of the same type shall be tested pursuant to paragraph 2. above.

If the test results for the second and the third vehicle fulfil the COP requirements of paragraph 8. of the main body of this Regulation, the vehicle is considered in compliance with regard to the COP.

If one of the test results of the second or third vehicle does not fulfil the COP requirements of paragraph 8. of the main body of this Regulation 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 7, paragraphs 4.to 4.3., should be deleted.

Insert a new Annex 10, to read:

"Annex 10

Measuring method to evaluate the compliance with the additional sound emission provisions

Only applicable for vehicles of categories M₁ and N₁ which are equipped with an internal combustion engine

1. Introduction

This annex describes a measuring method to evaluate the compliance of the vehicle with the additional sound emission provisions conforming to paragraph 6.2.3. of this Regulation. The expected noise emission in a particular gear ratio is approximated by a linear function of engine speed. The anchor point of this linear function is based on the test results of Annex 3.

Although the vehicle shall meet the requirements in this annex, it is not obligatory to perform actual tests when applying for type approval. It is obligatory for the manufacturer to sign a declaration of compliance in conformity with Appendix 1 to this annex. The type approval authority shall have the possibility to ask for additional information about the declaration of compliance and/or carry out the tests as described below.

The analysis of Annex 10 requires the performance of a test according to Annex 3. This Annex 3 test has to be performed under similar conditions on the same track as the tests according to this annex.

2. Measuring method

2.1 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, 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 the test report shown [Appendix 2 to this annex]**.

2.2. Method of testing

Unless specified differently here after, the conditions and procedures of Annex 3 paragraphs 3.1. to 3.1.2.1.2.2. shall be used.

Differing from Annex 3, single measurements are processed and evaluated.

** *Note by the secretariat:* Appendix 2 to Annex 10 does not exist in the current proposal and has still to be developed.

2.3. Control range

There is a range of valid operation conditions which have to fall within the following boundary conditions:

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} : $n_{BB} \leq 2.0 * \text{pmr}^{-0.222} * s$ 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

gears $k \leq$ highest gear measured in Annex 3,
 [k not first gear]

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.

2.4. Gear ratios

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

In the 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 shall be avoided. In that case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

2.5. Test of the vehicle

The path of the centerline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB'.

Before line AA' the accelerator shall be operated to a stable position, leading to a valid acceleration as defined in paragraph 2.3. above. The accelerator must not necessarily be fully depressed, as also partial throttle tests may be checked for compliance with the limit curve as defined in paragraph 3.3. The accelerator shall be kept in this stable position until the rear of the vehicle reaches line BB'.

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

- (a) The maximum A-weighted sound pressure level of the both sides of the vehicle indicated during each passage of the vehicle between the two lines AA' and BB', mathematically rounded to the first decimal place ($L_{wot,ki}$). 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.

- (b) The vehicle speed readings at AA' and BB' shall be reported with the first significant digit after the decimal place ($v_{AA,kj}$; $v_{BB,kj}$).
- (c) If applicable, the engine speed readings at AA' and BB' shall be reported as a full integer value ($n_{AA,kj}$; $n_{BB,kj}$).

The calculated acceleration shall be determined in accordance to the formulas in paragraph 3.1.2.1.2. of Annex 3 and reported to the second digit after the decimal place ($a_{wot,test,kj}$).

A test run is valid only if the measured vehicle performance and operation conditions fall inside the ASEP control range specified in paragraph 2.3. above.

3. Noise limitation

The maximum A-weighted sound pressure level recorded during a test run as specified above shall not exceed the limit curve defined below.

3.1. Anchor point

The anchor point is defined in terms of vehicle speed and sound pressure level.

The vehicle speed of the anchor point, v_{anchor} , is the effective vehicle speed at BB' of the acceleration test in Annex 3. In the case of a single gear test in gear i the vehicle speed of the anchor point is:

$$v_{anchor} = v_i$$

In the case of a two-gear test in gears i and $i+1$ the vehicle speed of the anchor point is the weighted average of the vehicle speeds in both gears, namely:

$$v_{anchor} = v_{i+1} + k * (v_i - v_{i+1})$$

Where k is the gear ratio weighting factor defined in paragraph 3.1.3.1. of Annex 3.

The sound pressure level of the anchor point, L_{anchor} is defined as:

$$L_{anchor} = L_{wot,Annex 3} + X + (L_{Annex 3} - L_{urban,Annex 3})$$

Where:

$L_{wot,Annex 3}$ is the reported value of the maximum sound pressure level of the acceleration test of Annex 3 as defined in paragraph 3.1.3.1.,

X is a general margin ($X^{***} = [3]$),

$L_{Annex 3}$ is the limit value of Annex 3 for the vehicle tested, and

$L_{urban,Annex 3}$ is the final test result of Annex 3 for the vehicle tested as defined in paragraph 3.1.3.1. of Annex 3.

3.2. Not-to-exceed (NTE) point

*** The value of the X, Y and Z coefficient is still in square brackets and may need additional discussion in GRB. They may also be tuned to the upcoming limits of Annex 3.

For each gear k tested, the NTE point is defined in terms of vehicle speed and sound pressure level.

The vehicle speed of the NTE point for gear k, $v_{NTE,k}$ is defined as the maximum vehicle speed at BB' for ASEP tests according to the definition of the control range in paragraph 2.3. above.

The sound pressure level of the NTE point, L_{NTE} is defined as:

$L_{NTE} = \text{Not To Exceed Level} = Y^{***} =$

[81 dB(A) for M_1 vehicles with $PMR \leq 150 \text{ kW/t}$

85 dB(A) for M_1 vehicles with $PMR \geq 150 \text{ kW/t}$

82 dB(A) for M_1 off road vehicles with $GVW > 2 \text{ t}$

82 dB(A) for N_1 vehicles with $GVW < 2 \text{ t}$

83 dB(A) for N_1 vehicles with $2 \text{ t} < GVW < 3,5 \text{ t}$]

Or:

[85 dB(A) for vehicles with $PMR \geq 150 \text{ kW/t}$

82 dB(A) for all other M_1 and N_1 vehicles]

3.3. Limit curve

The limit for a measurement in gear k is given as a function of vehicle speed v_k .

For vehicle speeds below the anchor point, the limit curve follows a fixed slope of $Z^{***} = [1]$ in units of dB/10 km/h:

$$L_{ASEP}(v_k) = L_{\text{anchor}} + Z * (v_k - v_{\text{anchor}}) / 10$$

For vehicle speeds above the anchor point, the limit curve is the linear connection between the anchor point and the NTE point:

$$L_{ASEP}(v_k) = L_{\text{anchor}} + (L_{NTE} - L_{\text{anchor}}) * (v_k - v_{\text{anchor}}) / (v_{NTE,k} - v_{\text{anchor}})$$

If the vehicle speed of the anchor point (v_{anchor}) exceeds the upper vehicle speed boundary of the ASEP control range (conforming to paragraph 2.3.), this latter part of the limit curve is obsolete.

4. Compliance tests

The Type Approval Authority may request tests to check the compliance of the vehicle with the requirements of this annex. To avoid undue work load, testing typically consists of two random test points in every valid gear. Pre-testing may be used to determine the most relevant test points. For all test points the control range as specified in paragraph 2.3. shall be met.

Annex 10

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 noise emission pursuant to UNECE 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 10

Appendix 2

[Reserved — see paragraph 2.1. to this annex]

II. Justification

A. Background

1. Traffic noise is a serious public health problem which is already recognized by the World Health Organization. The most cost-effective measures are those addressing the noise at its source. This was the background of the proposal for the 03 series of amendments to Regulation No. 51. In order to reduce effectively the noise by vehicles in a wider range of driving conditions, the Additional Sound Emission Provisions (ASEP) were introduced.

2. At the fifty-second session of the Working Party on Noise (GRB), the Chair introduced ECE/TRANS/WP.29/GRB/2010/9 proposing a possible approach for the incorporation of ASEP provisions into Regulation No. 51. This approach cannot be supported by the Netherlands because it does not sufficiently distinguish between noisy and silent vehicles. Vehicles with a maximum noise above 90 dB(A) could fulfil the requirements, while with this proposal many silent vehicles, with a maximum noise emission below 80 dB(A), would have difficulties to pass the test. Further information on this issue is given in Informal document Nos. GRB-52-15 and GRB-51-24.

3. The Netherlands prefer a system which is simple, straight forward, technology neutral and which limits the maximum noise emission. Therefore, the Netherlands put forward this updated ASEP proposal based on a Not To Exceed (NTE) level, expecting that it has significant benefits over earlier proposals related to this issue.

B. Changes in this update

5. Implementation of the improvement proposals presented at the fifty-second session of GRB in the report on Vehicle Noise Limit Values (VENOLIVA) (see Informal document No. GRB-52-07):

- (a) Remove the 2 m/s^2 boundary in the current method B in order to improve the position of the ASEP anchor point while it has a little effect on the test result.
- (b) Introduction of a slightly more lenient set of ASEP parameters XYZ:
 - (i) Increase the Delta L from 8 to:
 - Delta L = 12 for M_1 vehicles with $\text{PMR} > 150 \text{ kW/t}$
 - Delta L_p = 9 for all other vehicles
 - (ii) Increase the Margin from 2 to 3, following the recommendation of the technical service TNO of the Netherlands.

This reduces the "collateral damage" (amount of uncritical vehicles that fail ASEP) to less than 1 percent.
- (c) Increase the 4 m/s^2 boundary from the ASEP control range to 5 m/s^2 to enable testing of high-powered vehicles in second gear since many of these vehicles have an acceleration between 4 and 5 m/s^2 .
- (d) Define the limit curve in terms of noise emission as function of vehicle speed, rather than as function of engine speed, to enable testing a broader range of hybrid and electric vehicles.

- (e) Expand the ASEP requirements to partial throttle accelerations to cover all operating conditions of future vehicles, which is essential for the effectiveness of the combination of type approval and ASEP requirements.

6. Transition to a fixed NTE level in dB(A), instead of a delta relative to the Annex 3 type approval limit, following the remarks made by the experts from the United Kingdom of Great Britain and Northern Ireland and from the United States of America at the last sessions of GRB. It may solve the industry's criticism in case the Annex 3 limit was lowered, since this proposal would not consequently become overly stringent.

7. NTE level is based on the following starting points:

- (a) The equivalent limits at Annex 3 as determined in page 34 of the TNO report.
- (b) Delta L_p as given above.

This leads to the following NTE levels:

- 81 dB(A) for M_1 vehicles with $PMR \leq 150$ kW/t
- 85 dB(A) for M_1 vehicles with $PMR \geq 150$ kW/t
- 82 dB(A) for M_1 off road vehicles with $GVW > 2$ t
- 82 dB(A) for N_1 vehicles with $GVW < 2$ t
- 83 dB(A) for N_1 vehicles with $2 \text{ tons} < GVW < 3,5$ t]

Although, an agreement on a simpler list could be reached, e.g.:

- 85 dB(A) for vehicles with $PMR \geq 150$ kW/t
- 82 dB(A) for all other M_1 and N_1 vehicles

8. Finally, some issues of the current text of the Regulation have been fine tuned.

C. Clarification of changes in the proposal prepared by the Netherlands and differences to the proposal prepared by the informal group on ASEP as they appear in Annex 10

9. This chapter is based on working paper GRBIG-ASEP-16-003, which contains the two alternatives for ASEP that were discussed in GRB at its September 2009 session. Proposal 1 was prepared by the informal group on ASEP (Informal document GRB-50-01) and Proposal 2 was prepared by the Netherlands (ECE/TRANS/WP.29/GRB/2009/5). Where the two proposals are identical, the text continues in a single column. In case of marginal differences such as "COP" versus "Conformity Of Production" or "shall be" versus "have to be", only the first variant has been used.

10. Modifications between this proposal and the one prepared previously by the Netherlands are marked in bold for new or as strikethrough for deleted text.

"Annex 10**Measuring method to evaluate the compliance with the additional sound emission provisions****Only applicable for vehicles of categories M₁ and N₁ which are equipped with an internal combustion engine**

1. Introduction

This annex describes a measuring method to evaluate the compliance of the vehicle with the additional sound emission provisions in conformity with paragraph 6.2.3. of this Regulation. The expected noise emission in a particular gear ratio is approximated by a linear function of engine speed. The anchor point of this linear function is based on the test results of Annex 3.

Proposal 1	Proposal 2
The slope of this linear function is based on actual test results and limited to a maximum value.	No text

Although the vehicle shall meet the requirements in this annex, it is not obligatory to perform actual tests when applying for type approval. It is obligatory for the manufacturer to sign a declaration of compliance conforming to Appendix 1 to this annex. The type approval authority shall have the possibility to ask for additional information about the declaration of compliance and/or carry out the tests as described below.

The analysis of Annex 10 requires the performance of a test according to Annex 3. This Annex 3 test has to be performed under similar conditions on the same track as the tests according to this annex.

2. Measuring method

2.1 Measuring instruments and condition of measurements

Unless specified differently hereafter, the measuring instruments, the conditions of the measurements and the condition of the vehicle are equal 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 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 the test report shown Appendix 2 to this annex.

2.2. Method of testing

Unless specified differently here after, the conditions and procedures of Annex 3 paragraphs 3.1. to 3.1.2.1.2.2. shall be used.

Differing from Annex 3, single measurements are processed and evaluated.

2.3. Control range

There is a range of valid operation conditions which have to fall within the following boundary conditions:

- Vehicle speed V_{AA_ASEP} : $v_{AA} \geq 20$ km/h
- Vehicle acceleration a_{WOT_ASEP} : $a_{WOT} \leq 4.05.0$ 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
 - gears $k \leq$ highest gear measured in Annex 3, [k not first gear]

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.

2.4. Gear ratios

The ASEP requirements apply to every gear ratio k 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 shifting which leads to a condition that is not in compliance with the boundary conditions shall be avoided. In that case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

Proposal 1	Proposal 2
<p>2.5. Target conditions</p> <p>The sound emission shall be measured in each valid gear ratio at the four test points as specified below.</p> <p>The first test point P_1 is defined by using an entry speed v_{AA} of 20 km/h. If a stable acceleration condition cannot be achieved the speed shall be increased in steps of 5 km/h until a stable acceleration is reached.</p> <p>The fourth test point P_4 is defined by the maximum vehicle speed at BB' in that gear ratio within the boundary conditions according to paragraph 2.3.</p> <p>The other 2 test points are defined by the following formula: Test Point P_j: $v_{BB_j} = v_{BB_1} + ((j - 1) / 3) * (v_{BB_4} - v_{BB_1})$ for j = 2 and 3</p> <p>Where: v_{BB_1} = vehicle speed at BB' of test point P_1 v_{BB_4} = vehicle speed at BB' of test point P_4</p> <p>Tolerance for v_{BB_j}: ± 3 km/h</p> <p>For all test points the boundary conditions as specified in paragraph 2.3. shall be met.</p>	<p>No text</p>

Proposal 1		Proposal 2	
2.6.	Test of the vehicle	2.5.	Test of the vehicle

The path of the centerline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB'.

Proposal 1	Proposal 2
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. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.	Before line AA' the accelerator shall be operated to a stable position, leading to a valid acceleration as defined in paragraph 2.3 above. The accelerator must not necessarily be fully depressed, as also partial throttle tests may be checked for compliance with the limit curve as defined in paragraph 3.3. The accelerator shall be kept in this stable position until the rear of the vehicle reaches line BB'.

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

- (a) The maximum A-weighted sound pressure level of the both sides of the vehicle indicated during each passage of the vehicle between the two lines AA' and BB', 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.
- (b) The vehicle speed readings at AA' and BB' shall be reported with the first significant digit after the decimal place ($v_{AA,kj}$; $v_{BB,kj}$).
- (c) If applicable, the engine speed readings at AA' and BB' shall be reported as a full integer value ($n_{AA,kj}$; $n_{BB,kj}$).

The calculated acceleration shall be determined in accordance to the formulas in paragraph 3.1.2.1.2. of Annex 3 and reported to the second digit after the decimal place ($a_{wot,test,kj}$).

Proposal 1	Proposal 2
No text	A test run is valid only if the measured vehicle performance and operation conditions fall inside the ASEP control range specified in paragraph 2.3. above.

Proposal 1	
3.	Analysis of results
3.1.	Determination of the anchor point for each gear ratio

For measurements in gear i and lower, the anchor point consists of the maximum sound level L_{woti} , the reported engine speed n_{woti} and vehicle speed v_{woti} at BB' of gear ratio i of the acceleration test in Annex 3.

$$L_{anchor,i} = L_{woti,Annex\ 3}$$

$$n_{anchor,i} = n_{BB,woti,Annex\ 3}$$

$$v_{anchor,i} = v_{BB,woti,Annex\ 3}$$

For measurements in gear $i+1$ the anchor point consists of the maximum sound level L_{woti+1} , the reported engine speed n_{woti+1} and vehicle speed v_{woti+1} at BB' of gear ratio $i+1$ of the acceleration test in Annex 3.

$$L_{anchor,i+1} = L_{woti+1,Annex\ 3}$$

$$n_{anchor,i+1} = n_{BB,woti+1,Annex\ 3}$$

$$v_{anchor,i+1} = v_{BB,woti+1,Annex\ 3}$$

3.2. Calculation of the slope of the regression line for each gear

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

3.2.1. Calculation of the regression line as function of engine speed

The linear regression line is calculated using the anchor point and the four correlated additional measurements.

$$Slope_k = \frac{\sum_{j=1}^5 (n_j - \bar{n})(L_j - \bar{L})}{\sum_{j=1}^5 (n_j - \bar{n})^2} \quad (\text{in dB/1000 rpm})$$

$$\text{With: } \bar{L} = \frac{1}{5} \sum_{j=1}^5 L_j ;$$

$$\bar{n} = \frac{1}{5} \sum_{j=1}^5 n_j ;$$

Where:

n_j = engine speed measured at line BB'

3.2.2. Slope for further calculation

The slope of a particular gear for the further calculation is the derived result of the calculation formula under paragraph 3.2.1. rounded to the first decimal place, but not higher than [6] dB/1000 rpm

3.3 Calculation of the linear noise level increase expected for each measurement

The sound level $L_{ASEP,kj}$ for measurement point j in gear k shall be calculated using the engine speeds measured for each measurement point, using the slope determined in paragraph 3.2. relative to the specific anchor point for each gear ratio.

For $n_{BB,kj} \leq n_{anchor,k}$:

$$L_{ASEP,k,j} = L_{anchor,k} + (Slope_k - Y) * (n_{BB,k,j} - n_{anchor,k}) / 1000$$

For $n_{BB,k,j} > n_{anchor,k}$:

$$L_{ASEP,k,j} = L_{anchor,k} + (Slope_k + Y) * (n_{BB,k,j} - n_{anchor,k}) / 1000$$

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

Every individual noise measurement shall be evaluated.

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

$$L_{kj} \leq L_{ASEP,k,j} + [2 \text{ dB(A)}] + [(Limit_{Annex 3} - L_{urban,Annex 3})]$$

If the measured noise level in 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 above specification.

[5. To avoid the possibility for vehicles to become significantly more noisy under the conditions regulated in the former Regulation No. 51, a reference value L_{ref} shall be determined out of the calculated regression line as follows:

(a) The determination of gear k with $k=3$ for manual transmission and lockable automatic transmission with up to 5 gears and $k=4$ for lockable automatic transmission with 6 or more gears. In the case of a non lockable automatic gear box the gear k shall be chosen by the ASEP – Test diagram in the way, that V_{BB} is nearest to 61 km/h.

(b) Calculation of $n_{ref,k}$ in accordance to vehicle speed V_{ref} at the respective gear ratio k with:

$$V_{ref} = V_{BB} = 61 \text{ km/h}$$

(c) Calculation of L_{ref} with:

$$L_{ref} = L_{anchor,k} + Slope_k * (n_{ref,k} - n_{anchor,k}) / 1000$$

The Limit for L_{ref} shall be 76dB(A).

For vehicles fitted with a manual gear box having more than four forward gears and equipped with an engine developing a maximum power greater than 140 kW (ECE) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be increased by 3 dB(A).

For vehicles fitted with an automatic gear box having more than four forward gears and equipped with an engine developing a maximum power greater than 140 kW (ECE) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be increased by 2 dB(A).]

Proposal 2	
3.	<p>Noise limitation</p> <p>The maximum A-weighted sound pressure level recorded during a test run as specified above shall not exceed the limit curve defined below.</p>
3.1.	<p>Anchor point</p> <p>The anchor point is defined in terms of engine vehicle speed and sound pressure level.</p> <p>The engine vehicle speed of the anchor point, n_{anchor}, v_{anchor}, is the effective engine vehicle speed at BB' of the acceleration test in Annex 3. In the case of a single gear test in gear i the engine vehicle speed of the anchor point is:</p> $n_{\text{anchor}} = n_i$ $v_{\text{anchor}} = v_i$ <p>In the case of a two-gear test in gears i and i+1 the engine vehicle speed of the anchor point is the weighted average of the engine vehicle speeds in both gears, namely:</p> $n_{\text{anchor}} = n_{i+1} + k * (n_i - n_{i+1})$ $v_{\text{anchor}} = v_{i+1} + k * (v_i - v_{i+1})$ <p>Where k is the gear ratio weighting factor defined in paragraph 3.1.3.1. of Annex 3.</p> <p>The sound pressure level of the anchor point, L_{anchor} is defined as:</p> $L_{\text{anchor}} = L_{\text{wot,Annex 3}} + X + (L_{\text{Annex 3}} - L_{\text{urban,Annex 3}})$ <p>Where:</p> <p>$L_{\text{wot,Annex 3}}$ is the reported value of the maximum sound pressure level of the acceleration test of Annex 3 as defined in paragraph 3.1.3.1.,</p> <p>X is a general margin ($X = [2] [3]$),</p> <p>$L_{\text{Annex 3}}$ is the limit value of Annex 3 for the vehicle tested, and</p> <p>$L_{\text{urban,Annex 3}}$ is the final test result of Annex 3 for the vehicle tested as defined in paragraph 3.1.3.1. of Annex 3.</p>
3.2.	<p>Not-to-exceed (NTE) point</p> <p>For each gear k tested, the NTE point is defined in terms of engine vehicle speed and sound pressure level.</p> <p>The engine vehicle speed of the NTE point for gear k, $n_{\text{NTE,k}}$, $v_{\text{NTE,k}}$, is defined as the maximum engine vehicle speed at BB' for ASEP tests according to the definition of the control range in paragraph 2.3. above.</p> <p>The sound pressure level of the NTE point, L_{NTE} is defined as:</p> $L_{\text{NTE}} = \text{Limit}_{\text{Annex 3}} + Y$ <p>Where:</p> <p>$\text{Limit}_{\text{Annex 3}}$ is the limit value of Annex 3 for the vehicle tested, and</p> <p>Y is the allowed noise increase in the ASEP control range ($Y = [8]$).</p>

L_{NTE} = Not To Exceed Level = Y =

[81 dB(A) for M_1 vehicles with $PMR \leq 150$ kW/t

85 dB(A) for M_1 vehicles with $PMR \geq 150$ kW/t

82 dB(A) for M_1 off road vehicles with $GVW > 2$ t

82 dB(A) for N_1 vehicles with $GVW < 2$ t

83 dB(A) for N_1 vehicles with 2 t < $GVW < 3,5$ t]

Or:

[85 dB(A) for vehicles with $PMR \geq 150$ kW/t

82 dB(A) for all other M_1 and N_1 vehicles]

3.3. Limit curve

The limit for a measurement in gear k is given as a function of engine vehicle speed n_k v_k .

For engine vehicle speeds below the anchor point, the limit curve follows a fixed slope of $Z = [3]$ [1] in units of $\text{dB}/1000\text{-min}^{-1}$ $\text{dB}/10$ km/h:

$$\text{Limit}_{ASEP}(n_k) = L_{\text{anchor}} + Z * (n_k - n_{\text{anchor}}) / 1000$$

$$L_{ASEP}(v_k) = L_{\text{anchor}} + Z * (v_k - v_{\text{anchor}}) / 10$$

For engine vehicle speeds above the anchor point, the limit curve is the linear connection between the anchor point and the NTE point:

$$\text{Limit}_{ASEP}(n_k) = L_{\text{anchor}} + (L_{NTE} - L_{\text{anchor}}) * (n_k - n_{\text{anchor}}) / (n_{NTE,k} - n_{\text{anchor}})$$

$$L_{ASEP}(v_k) = L_{\text{anchor}} + (L_{NTE} - L_{\text{anchor}}) * (v_k - v_{\text{anchor}}) / (v_{NTE,k} - v_{\text{anchor}})$$

If the vehicle speed of the anchor point (v_{anchor}) exceeds the upper vehicle speed boundary of the ASEP control range (conforming to paragraph 2.3.), this latter part of the limit curve is obsolete.

4. Compliance tests

The Type Approval Authority may request tests to check the compliance of the vehicle with the requirements of this annex shall be carried out. To avoid undue work load, testing typically consists of two random test points in every valid gear. Pre-testing may be used to determine the most relevant test points. For all test points the control range as specified in paragraph 2.3. shall be met."