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1958 Agreement – Consideration of draft amendments to existing Regulations submitted by GRB

Proposal for amendments to Regulation No. 51 (Noise of M and N categories of vehicles)

Submitted by the Working Party on Noise*

The text reproduced below was adopted by the Working Party on Noise (GRB) at its fifty-third session to introduce Additional Sound Emission Provisions (ASEP) into the Regulation. It is based on ECE/TRANS/WP.29/GRB/2011/2, amended as reproduced in informal document GRB-53-27 (ECE/TRANS/WP.29/GRB/51, para. 15). It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) for information.

* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208/, para. 106 and ECE/TRANS/2010/8, 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.

Insert new paragraphs 6.2.3. to 6.2.3.3., to read:

"6.2.3. Additional sound emission provisions

The additional sound emission provisions (ASEP) apply only to vehicles of categories M_1 and N_1 equipped with an internal combustion engine.

Vehicles are deemed to fulfill 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 engine speed of the vehicles 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).

Vehicles of category N_1 are exempted from ASEP if one of the following conditions is fulfilled:

(a) The engine capacity is not exceeding 660 ccm and the power-to-mass ratio PMR calculated by using the maximum authorized vehicle mass is not exceeding 35.

(b) The payload is at least 850 kg and the power-to-mass ratio PMR calculated by using the maximum authorized vehicle mass is not exceeding 40.

The additional sound emission provisions 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 what can be expected from the Annex 3 test result for this specific vehicle.

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

6.2.3.2. The vehicle shall meet the requirements of Annex 10 to this Regulation.

6.2.3.3. 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 according 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.

Insert new paragraph 11.4., to read:

"11.4. For the first five years after the official entry into force of the 03 series of amendments to this Regulation, vehicles with a serial hybrid drive train which have an additional combustion engine with no mechanical coupling to the power train are excluded from the requirements of paragraph 6.2.3."

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 transmissions, 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 $a_{wot\ ref}$, not exceeding 3.0 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 3.0 m/s^2, use both gear ratios for the test. The weighting ratio in relation to the reference acceleration $a_{wot\ ref}$ is calculated by:

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

(c) If the acceleration value of gear ratio i exceeds 3.0 m/s^2, the first gear ratio shall be used that gives an acceleration below 3.0 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 3.0 m/s^2. In other cases, no other gear shall be used. The achieved acceleration $a_{wot\ test}$ during the test shall be used for the calculation of the part power factor k_P instead of $a_{wot\ ref}$.

(d) 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 $a_{wot\ ref}$.

(e) If rated engine speed is exceeded in a gear ratio before the vehicle passes BB' the next higher gear shall be used.

…"

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 (COP) according to paragraph 8. of this Regulation.

2. Testing procedure

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

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

2.2. Compressed air sound

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

2.3. 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 and subjected to the tests of paragraph 2. above. If the test results fulfill 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 fulfill 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 fulfill 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 fulfill 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."

Paragraphs 4.to 4.3., should be deleted.

Insert a new Annex 10, to read:

"**Annex 10**

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 method to evaluate compliance of the vehicle with the additional sound emission provisions (ASEP) conforming with paragraph 6.2.3. of this Regulation.

The vehicle shall meet the requirements in this annex. It is not mandatory to perform actual tests when applying for type approval. The manufacturer shall sign a declaration of compliance conforming to Appendix 1 of 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 described below.

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

2. Measuring method

2.1. Measuring instruments and condition of measurements

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

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

2.2. Method of testing

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

2.3. Control range

Operation conditions are as follows:

Vehicle speed V_{AA_ASEP}:	$v_{AA} \geq 20$ km/h
Vehicle acceleration a_{WOT_ASEP}:	$a_{WOT} \leq 5.0$ 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 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	$k \leq$ gear ratio i as determined in Annex 3

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

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 shift which leads to a condition that is not in compliance with the boundary conditions shall be avoided. In such a case, it is permitted to establish and use electronic or mechanical devices, including alternate gear selector positions.

2.5 Target conditions

The sound emission shall be measured in each valid gear ratio at the four test points as specified below.

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.

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.

The other two 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

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

Tolerance for v_{BB_j}: ±3 km/h

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

2.6. Test of the vehicle

The path of the centerline of the vehicle shall follow line CC' as closely as possible throughout the entire test, starting from the approach 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. The accelerator shall be kept in depressed condition until the rear of the vehicle reaches line BB'.

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.

The vehicle speed readings at AA' and BB' shall be reported with the first significant digit after the decimal place. ($v_{AA,kj}$; $v_{BB,kj}$)

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 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

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. 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 slope of the regression line for each gear

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

$$Slope_k = \frac{\sum_{j=1}^{5}(n_j - \overline{n})(L_i - \overline{L})}{\sum_{j=1}^{5}(n_j - \overline{n})^2} \text{ (in dB/1000 min}^{-1}\text{)}$$

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

where n_j = engine speed measured at line BB'

3.2.2 Slope of the regression line for each gear

The $Slope_k$ 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/1000 min^{-1}."

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

The sound level $L_{ASEP,kj}$ for measurement point j and gear k 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 $n_{BB\_k,j} \leq n_{anchor,k}$:

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

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:

$L_{kj} \leq L_{ASEP\_k.j} + x$

With:

x = 3 dB(A) for vehicle with a non-lockable automatic transmission or non-lockable CVT

x = 2 dB(A) + limit value - L_{urban} of Annex 3 for all other vehicles

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

5. Reference sound assessment

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

5.1. The determination of gear k is as follows:

k = 3 for all manual transmission and for automatic transmission with up to 5 gears;

k = 4 for automatic transmission with 6 or more gears.

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

5.2. Determination of reference engine speed n_{ref_k}

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

5.3. Calculation of L_{ref}

$L_{\mathbf{ref}} = L_{\mathbf{anchor\_k}} + Slope_k * (n_{\mathbf{ref\_k}} - n_{\mathbf{anchor\_k}}) / 1000$

L_{ref} shall be less than or equal to 76 dB(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 (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be less than or equal to 79 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 (according to Regulation No. 85) and having a maximum-power/maximum-mass ratio greater than 75 kW/t, L_{ref} shall be less than or equal to 78 dB(A).

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 kp_ASEP as follows:

kp_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 - kp_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 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.

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 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: ....."