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Working Party on Noise

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Item 3(c) of the provisional agenda

REGULATION No. 51
(Noise of M and N categories of vehicles)

Proposal for amendments to Regulation No. 51

Submitted by the expert from the Netherlands ^{*/}

The proposal reproduced below was prepared by the expert from the Netherlands. It contains a draft proposal for changes to the text of method B specified in Regulation No. 51 - Revision 1 - Amendment 3 in order to incorporate Additional Sound Emission Provisions (ASEP). ASEP are assumed to be added as Annex 10, while the type approval method is assumed to be described in Annex 3. The numbering of annexes deviates from Regulation No. 51 - Revision 1 - Amendment 3 in which Annex 10 is used for method B. This proposal deviates from the proposal currently under development by the Working Party on Noise (GRB) informal group on ASEP for the reasons given in the justification. The modifications to the current text of the Regulation are marked in **bold** 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 performance of vehicles. The present document is submitted in conformity with that mandate.

A. PROPOSAL

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

"6.2.3. Additional sound emission provisions

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

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 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. These measures are commonly referred to as "cycle detection".**

This shall not prevent the installation on a vehicle of any control device, function, system or measure if:

- (a) it is activated only for such purposes as engine protection, cold starting or warming up, or**
- (b) it is activated only for such purposes as operational security or safety and limp-home strategies.**

- 6.2.3.2. The vehicle shall meet the requirements of Annex 10.**

- 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."**

Paragraph 8., 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."**

Annex 7, amend to read:

"Annex 7

CHECKS ON CONFORMITY OF PRODUCTION

1. General

These requirements are consistent with the test to be held to check conformity of production 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 (ASEP)

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 conformity of production requirements of paragraph 8. of the main body of this Regulation, the vehicle is considered to be in compliance with the conformity of production provisions.

If one of the test results does not fulfill the conformity of production 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 conformity of production requirements of paragraph 8. of the main body of this Regulation, the vehicle is considered in compliance with conformity of production provisions.

If one of the test results of the second or third vehicle does not fulfill the conformity of production 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 10, amend to read (inserting also a new Appendix 1):

"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 conform paragraph 6.2.3. of this Regulation. The maximum allowable sound emission is given 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 conform with Appendix 1. The type approval authority and technical service shall have the possibility to ask for additional information about the declaration of compliance and/or carry out the tests as described below.

Vehicles are deemed to fulfill the requirements of this annex, if the vehicle manufacturer provides technical documents to the type approval authority showing that the difference between maximum and minimum of the vehicle's engine speed at BB' for any test condition inside the ASEP control range defined in paragraph 2.3. below (including Annex 3 conditions) does not exceed $0.15 * (S-n, idle)$. This article is intended especially for non-lockable CVT's.

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 Annex 10.

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 (such as control systems of the transmission, the driving performance or the sound emission), all these modes shall be in compliance with the requirements in this annex.

2.2. Method of testing

Unless specified differently here after, the conditions and procedures of Annex 3 paragraphs 3.1. through 3.1.2.1.2.2. shall be used. Differing from Annex 3, single measurements are processed and evaluated rather than averages of four measurements for the same test condition.

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} :	$V_{AA} \geq 20 \text{ km/h}$
Vehicle speed V_{BB_ASEP} :	$V_{BB} \leq 80 \text{ km/h}$
Vehicle acceleration a_{WOT_ASEP} :	$a_{WOT} \leq 4.0 \text{ m/s}^2$
Engine speed n_{BB_ASEP} :	$n_{BB} \leq 2.0 * pmr^{-0.222} * s \text{ or}$ $n_{BB} \leq 0.9*s \text{ whichever is the lowest}$

2.4. Gear ratios

The ASEP requirements apply to every gear ratio k that leads to test results within the boundary conditions as defined in paragraph 2.3. in this annex, with the following restrictions:

In the case of vehicles tested with fixed gear ratios, only gears below and including those gears tested in Annex 3 shall be used.

In case of vehicles with automatic transmissions, adaptive transmissions and continuously variable transmissions (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.

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'.

For every test run j in every valid gear k 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) The engine speed readings at AA' and BB' shall be reported as a full integer value ($n_{AA,kj}$; $n_{BB,kj}$).
- (d) The calculated acceleration shall be determined in accordance to the formulas in Annex 3, paragraph 3.1.2.1.2. 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 engine speed and sound pressure level.

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

$$n_{anchor} = n_i.$$

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

$$n_{\text{anchor}} = n_{i+1} + k^*(n_i - n_{i+1}),$$

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

$$L_{\text{anchor}} = L_{\text{wot,annex 3}} + X + (\text{Limit}_{\text{Annex 3}} - L_{\text{urban,Annex 3}})$$

where:

$L_{\text{wot,Annex 3}}$ 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. of Annex 3,

X is a general margin ($X = [2]$),

$\text{Limit}_{\text{Annex 3}}$ is the limit value of Annex 3 for the vehicle tested, and

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

3.2. Not-to-exceed (NTE) point

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

The engine speed of the NTE point for gear k , $n_{\text{NTE},k}$, is defined as the maximum engine 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:

$$L_{\text{NTE}} = \text{Limit}_{\text{Annex 3}} + Y$$

where:

$\text{Limit}_{\text{Annex 3}}$ is the limit value of Annex 3 for the vehicle tested, and

Y is the allowed noise increase in the ASEP control range ($Y = [8]$).

3.3. Limit curve

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

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

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

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

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

4. COMPLIANCE TESTS

The type approval authority as well as the technical service 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 2 random test points in every valid gear. Pre-testing may be used to determine the most relevant test points. For all test points the boundary conditions as specified in paragraph 2.3. shall be met.

Appendix 1 to Annex 10
(Maximum format: A4 (210 x 297 mm))

Statement of compliance with the Additional Sound Emission Provisions

..... (Name of manufacturer) attests that vehicles of this type
..... (type with regard to its noise emission pursuant to ECE
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: "

B. JUSTIFICATION

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 source. This was the background for the introduction of Regulation No. 51, 03 series of amendments. In order to reduce effectively the noise by vehicles in a wider range of driving conditions the Additional Sound Emission Provisions (ASEP) were introduced.

In the GRB informal group on ASEP a system, developed by the International Organization of Motor Vehicle Manufacturers (OICA), is under discussion.

This system cannot be supported by the Netherlands. It does not give sufficient noise limits for engine speeds above those mentioned in Annex 3. This fact could lead to the situation that vehicles become significantly louder in the higher engine speed area compared to what is allowed by the existing regulation. Further information on this issue is given in working papers GRBIG-ASEP-13-008 and GRBIG-ASEP-13-011.

The Netherlands prefer a system which is simple, straight forward and less lenient. Therefore, an alternative ASEP system was developed which is presented to the members of GRB in this formal document.

It is based on the following elements:

1. an anchor point (determined from measurements of Annex 3);
2. a not to exceed point (Annex 3 limit value plus a delta);
3. above the anchor point: a straight line between the anchor point and the not to exceed point;
4. below the anchor point: a line with a fixed slope;
5. a bonus for silent vehicles;
6. a margin (to allow for uncertainty of single measurements).

With the present state of the art of technology, these demands can be fulfilled.

The ASEP system proposed in this document is simpler and easier to perform than the method presented by OICA. In addition, it is able to tackle the problem of noisy vehicles.
